the glass industry
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All-Electric Melting of Glass

By L. PENBERTHY, Seattle, Washington
and
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MELTING OF GLASS by electric heat is not new, of course. But since the technology of this method and the world economics of fuels have both been changing over the past few years, it is worthwhile to examine the place of electric melting as it appears now.

The question can be discussed more logically by dividing glass melting into the following categories;

1. Glasses having a volatile component.
2. Dark-colored glasses.
3. Small furnaces.
4. Medium and large furnaces.
   a. Basic power cost.
   b. Boosters.
   c. Repair cost.
   d. Low-cost electricity.
   e. Space.
   f. Capital outlay.

1. Glasses Having a Volatile Component

All-electric melting is the best method for melting fluoride, phosphate, borosilicate and similar glasses. When a flame sweeps across such glasses in a normal fuel-fired furnace, large quantities of the volatile ingredient are swept away and up the stack. In the case of fluoride, this is objectionable because of the health hazard. For all of such glasses, the loss is objectionable because the surface layers of the glass remaining thus become a different composition from that of the glass below. This could lead to trouble in homogeneity.

When melting all-electrically, the heat is liberated below the batch blanket. Vapors from the batch ingredients pass upward through, and are captured by, the cold batch. The concentration of such volatile components quickly builds up to a high level in the batch layer so that the glass going through the throat soon stabilizes in equilibrium with the batch being charged into the furnace.

Thus, one of the important factors in favor of all-electric melting is that the precise control of glass composition is made possible.

Cost of melting such glasses all-electrically is usually reasonable when the saving of the volatile component is considered. For example, it is common for a fluoride batch to contain 9 per cent F_2 for fuel firing in order to retain 5 per cent F_2 in the final glass. In all-electric melting, the batch contains only 5.2 per cent F_2 for the same result.

2. Dark Colored Glasses.

The color of the glass is of little consequence when melting electrically. Electric heat is released *inside* the body of the glass, and since the electric current can be made to pass with reasonable uniformity throughout the entire volume of the glass, only small temperature differences exist.

For example, a high-iron amber glass in an electric tank furnace four feet deep showed a temperature near the bottom only 25°F colder than the glass near the top. In another example, glasses containing up to 12 per cent iron oxide have been melted with ease, the same as white flint. Glasses containing up to 1.3 per cent chromium oxide melt just as easily.

All-electric melting is therefore worth considering right now for dark glasses, even for bottles. The eco-

This paper was written especially for THE GLASS INDUSTRY and was presented at the October meeting of the Union Scientifique Continentale du Verre in Brussels, Belgium.

Table I.

Rated Furnace Output Per Day	Power Consumption Per Short Ton Glass	Per Kg. Glass
1 ton	1440 KWH	1.58 KWH
2 tons	1270	1.40
4 "	1130	1.24
10 "	920	1.01
20 "	800	0.88
30 "	780	0.86
40 "	760	0.84
50 "	740	0.82
60 "	720	0.80

nomic advantages of this method are based on the excellent homogeneity of the glass and freedom from stones.

3. Small Furnaces

Where small quantities of soda-lime glass are required, all-electric melting can generally compete directly with fuel melting. There is no sharp border line for the term "small," but the statement certainly applies in the range of 1 to 10 short tons per day, and even larger.

It is true that small all-electric furnaces are not as efficient as large all-electric furnaces, in the same way that small fuel-fired furnaces are not as efficient as large fuel-fired furnaces. In a small furnace producing only one ton per 24 hours, the energy consumption is 1440 kilowatt hours per ton of glass (1.58 KWH/kg). whereas in a larger furnace producing 20 tons of glass per day, the energy consumption is only 800 KWH per ton of glass (0.880 KWH/kg). These figures are for glass of excellent bottle quality, any color.

Table I gives the power consumption per ton of glass in furnaces of various sizes which are operating at rated capacity.

These figures are subject to variation based on different refractories, insulation, cullet ratios, and batch materials. The above figures assume 15 per cent cullet, limestone (not burned lime), and sillimanite or flux clay refractories.

(The writer attempted to obtain corresponding figures of fuel consumption for fuel-fired furnaces, but found the variation from source to source was too wide for presentation here.)

4. Medium and Large Furnaces.

a. The largest all-electric furnace to date produces 58 tons of glass per day regularly. A furnace for 77 tons is in construction. There is no known principle which would limit the size of all-electric furnaces technically. But inspection of Table I will show that there are economic limitations in most areas of the world. The power consumption is not likely to go below 650 KWH per short ton (0.715 KWH per kg. glass), no matter how big the furnace.

At $0.008 per KWH, this means a power cost of $5.20 per ton by electric melting, whereas fuel melting in good large furnaces can be expected to produce glass at a fuel cost somewhat lower. This can be a deciding factor for large furnaces, such as 200 tons per day. Only in low-cost electricity or high-cost fuel areas is this factor likely to be reversed for large furnaces. (See *b* and *c*).

b. It should be noted that the foregoing paragraph refers to all-electric melting, not to boosting. Electric booster melting has already proven to be highly profitable in even the largest furnaces in any industrial area since a booster will enable the furnace to produce even

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Table II.

Construction Cost for All-Electric Furnaces.

	4 tons/day		30 tons/day		60 tons/day	
	Quantity (pounds)	*Cost $*	*Quantity (pounds)*	*Cost $*	*Quantity (pounds)*	*Cost $*
Weight of steel, furnace, and glass	43,000		170,000		290,000	
Steel	5,000	560	15,000	1,700	22,000	2,500
Steel erection		1,000		2,000		2,500
Floor, pot clay plus 3" paving	9,500	900	41,000	3,900	71,500	6,900
Sidewalls, sillimanite or high quality flux clay	12,500	1,700	27,000	3,100	33,000	3,700
Breastwalls & crown, low-duty silica	9,000	700	32,500	2,500	60,000	4,500
Refractories erection		1,600		5,000		7,500
Power Supply for	200 KW		1000 KW		1800 KW	
All electrical equipment including main switch. transformer, meters, electrodes, and secondary cables		3,000 to 7,000		12,000 to 25,000		20,000 to 35,000
Electrical installation labor		1,000		4,000		5,000
Total		$10,460 to $14,460		$32,200 to $47,200		$52,600 to $67,600

The Glass Industry—1958

(Conclusion)

By H. E. Simpson
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VI—Electronics

It is estimated that the manufacturers' sales of receiving tubes in 1958 approximated 328 million tubes (457 million in 1957), and the manufacturers' sales of picture tubes, approximately 7.5 million (9.7 million in 1957).

On the other hand, it is further estimated that factory sales of all kinds of electronic products reached a record $17 billion in 1958.

Military electronic sales registered the greatest gain over those in 1957, primarily because of the emphasis on missiles and aircraft guidance systems. More than 50 per cent of the missiles are electronic, in some form or other. Military volume for 1958 was about $4.1 billion; some 70 per cent of this total was for missiles and aircraft products, and 30 per cent for older-type electronics such as radar, sonar, and two-way mobile radio equipment.

Mr. Hull, president of the Electronic Industries Association, cites the following figures to show the shift in defense spending from aircraft to missiles: "In 1957, sales of electronic parts and components for missiles were $1.2 billion, compared with $1.3 billion for aircraft systems. This year (1958) there will be $1.3 billion for missiles and $1.6 billion for aircraft. Next year missiles will take $2 billion, and aircraft electronics $1.4 billion."

Mr. Hull also predicts that factory sales of electronic products in 1959 will reach about $8.3 billion. Military orders will total $4.4 billion; industrial electronic products, $1.5 billion; consumer products, $1.4 billion; and replacement parts, $1.0 billion.

Industrial electronic equipment sales in 1958 reached about $1.4 billion compared with $1.3 billion in 1957. The largest individual product gain was seen in testing and measuring devices, computers and other data-processing machinery, and in nuclear electronic instruments, which registered the highest percentage increase in sales. Sales of nuclear instruments in 1958 are estimated at $35 million compared to $27 million in 1957.

The only industry segment to show a sales loss in 1958 (compared to 1957) was that of consumer electronic products. Television sets, radios and phonographs accounted for only 17 per cent of the industry dollar volume compared with 20 per cent in 1957. The last few months of 1958 showed a splendid recovery for black-and-white television sales, and it is hoped that this improved market will continue.

Table IV indicates the sales distribution by screen size for 1957:

TABLE IV

Manufacturers' Sales of Picture Tubes

(by Screen Size*)

	1957
15″ and under	517,598
16″ thru 18″	2,231,449
19″ thru 21″	6,414,945
22″ thru 25″	534,570
26″ and Over	22,446
TOTAL	9,721,008

* Made from new Glass
Source: "Electronics Industry Fact Book 1958"

Color Television

Color TV is still quite expensive ($500 plus per set), and while much development and research are being conducted, the major uses and developments are believed to be several years off. During the year glass replaced metal in the manufacture of color television tubes and contributed to quality improvement in color sets. Although still small, the demand for color television sets continues to show encouraging growth.

Electronic Components

Since the beginning of the radio industry, Corning has been blowing tube enclosures by the million on its high-speed ribbon machines. Last year, the company followed up on the latest major development in elec-

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CARLSON

BISHOP

BURCH

SCHMIDT

SIEFERT

Annual Symposium

• TEN PAPERS WERE DELIVERED at the afternoon symposium on refractories, held January 19, in conjunction with the Toledo Glass and Ceramic Award, in Doerman Theater, University of Toledo. Dr. Archie N. Solberg. Dean of the University Research Foundation, opened the meeting with a friendly welcome and introduced Dr. William N. Carlson, new president of the University.

Dr. Carlson discussed the possible significance to the scientific field in general of a winter meeting of the Nuclear Society held at Detroit. One hundred ninety papers were presented during 4 days of four simultaneous sessions. These papers represented contributions from 70 organizations, of which only nine were Universities. There were University papers, amounting to 8 per cent of the total.

Dr. Carlson wondered if the Universities, by default, are giving up their part in research to government-sponsored programs. Present-day government research. he said. is being directed more and more toward short-term problems whose capability for solution is almost predictable. He concluded that perhaps we are neglecting the unpredictable type of fundamental research which is so important.

Robert J. McEvoy. Owens-Corning Fiberglas Corp., and chairman, Northwestern Ohio Section, American Ceramic Society. welcomed the guests to this fourth Toledo Award and the second Symposium. Thereupon he turned the meeting over to Dr. Fred Bishop, Owens-Illinois, who was the moderator of the symposium on "The Future of Refractories for Glass Tanks." The panel was composed of representatives from four refractory users and four refractory manufacturers.

Oscar G. Burch, vice-president of Engineering and Research, Owens-Illinois Glass Co., showed slides illustrating the trend toward higher average tonnage (lower square feet per ton) and longer campaigns. He predicted a reversal in this trend because customers are complaining more frequently about previously acceptable visible defects, such as blisters, stones and cords which do not, however, affect the normal use of the product.

Beuther L. Schmidt, Anchor-Hocking Glass Co. More extensive use of artificial bath agitation and electric booster melting is changing the refractory needs of modern glass manufacturers. More heat shock resistance is needed on the throat cap blocks and, in general, refractories of higher heat-shock resistance would be helpful. Suppliers, he urged, should study the effects of changes in grain size and minor impurities in their refractory raw materials.

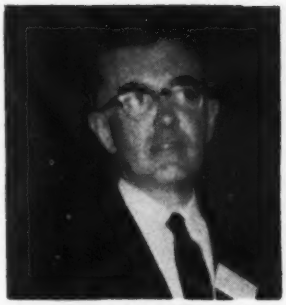
August C. Siefert, research director, Owens-Corning Fiberglas Corp., emphasized the need of refractories to withstand higher temperatures. Because of a demand

—University of Toledo

GREGORIUS

for fiber glass with a higher modulus of elasticity for reinforced plastics, higher melting temperatures are now required. This means, of course, temperature-resisting refractories. Dr. Siefert wants to use specifically suited refractories in melting, refining, homogenizing and other furnace operations.

Joseph Gregorius, technical advisor, Pittsburgh Plate Glass Co. There has been much progress in refractories during the past 45 years; for example, lower porosity as a result of vacuum slip-casting, and the introduction of basic refractories which withstand alkali carry-over. He hoped for progress in chemically bonded refractories with moderate strength up to 2000° without pre-firing.



BARNES

The first representative of a refractory manufacturer was *Wilson R. Barnes, Director of Technical Developments, Corhart Refractories Co.*, who said that better refractories are needed because of the continual progress being made in all phases of glass manufacture life, in glass quality, in quantity required and in temperature.

MILLER

William Miller, Carborundum Co., read a paper by Karl H. Sandmeyer who was unable to attend for the Carborundum Co. There should always be a good liaison between the refractory research quarters and the glass research quarters because intimate co-operation is necessary to progress in this field. Additional emphasis should be given to glass-refractory testing programs along the lines of those now being carried on in England.

THOMAS

Everett A. Thomas, chief ceramic engineer, Charles Taylor Sons Co. Mullite and Zircon refractories were pioneered by his company as successful substitutes for, and improvements over, the old Kyanite imports from India. Porosity of Zircon blocks has been worked down from 15 per cent to less than one per cent. Slides of their small continuous experimental refractory testing furnace were shown.

Raymond E. Birch, Research Director, Harbison Walker Refractories Co., looked into the future and predicted that there would be higher temperatures and more dust to contend with. While alkali-repelling basic checker brick is a great step forward, there are still problems regarding carry-over of sodium sulphate.

There was an active discussion period after the eight panel speakers had completed their program. Mr. Gregorius mentioned that the use of basic caps on glass furnaces was more difficult than on steel furnaces because the glass fire is wet (in alkali) while the steel furnace fire is dry (in alkali). The advantages and disadvantages of sweating the glass out of fused glass refractories before use were discussed. Conclusions were scarce for lack of measured facts. The merits of insulation on tank side walls was also mentioned.

BIRCH

Dr. Games Slayter...

• • • A MAN OF GREATNESS. His strength arises from a sincere humility, and a keen understanding of the men who work with him. Perhaps one of his strongest attributes is one which he cannot see, because it is so much a part of him—the quality of his leadership which draws from his men those hidden talents and abilities of which they are not aware.

But his success goes way beyond this, too, for Games Slayter has always thought of his scientific achievements as a part of a larger plan. He never limits his thinking to just a patent or an invention. There must be a savings resulting from that achievement—corollary savings, he calls it—like a savings in time, shipping, raw material costs, marketing and packaging.

These attributes of greatness might have remained unrecognized if he had not been endowed with an insatiable curiosity, a desire to know more about the things around him, and, above all, an unending drive, always urging him to improve the comfort and living standards of people.

When Games Slayter graduated from Purdue University, he set up his own business in heating plants and metallurgy. Many of his customers complained that his oil burners consumed too much fuel, so he began looking into ways of improving the insulation materials. He tried ground-up corn cobs and gypsum, for fireproofness, and melted rock whipped into a foam and cooled. At that time he knew nothing about glass and was surprised when his patent attorney told him that this actually was glass.

His attorney was also working for Owens-Illinois, and it was not long before an introduction had been arranged in 1931 between Dr. Slayter and Mr. W. E. Levis, then president of the company.

At first the young chemical engineer-inventor worked as a consultant for Owens-Illinois on a one-day-a-week basis. He was assigned the task of making any new products from glass at the Evansville, Indiana, plant which was largely idled by the early Depression years.

They soon found that new products could not be developed quite that fast; the plant closed on December 31, 1931, and the laboratory moved to Columbus.

The rest of the story Games Slayter tells with warmth and color in his acceptance speech on receiving the Toledo Award. In his disarming manner, he will always tell you that it is true he has made a small contribution to glass technology, but he could not have done it without the help of his many friends and associates.

He insists that he should not be singled out as the recipient of the 1959 Toledo Award without first realizing that this high honor is also in recognition of all those learned scientists and capable business men who have shared their wide knowledge and experience with him.

Dr. Slayter has long since earned the revered title of "Father of Fiberglas" among his scientific peers. It is he who persevered, lent courage and stamina, and kept his faith in fiber glass, especially during those early years when it was so easy to spend money on research and so hard to see the results.

Even then, he kept his standards high and pursued his goal with a relentless drive, always asking, "What are the advantages? The potentials? The corollary savings?"

In the first few years, when fiber glass did not look promising in the insulation field, he was planning far ahead. Mineral rock wool at that time cost 75 cents a ton for batch, and fiber glass, $8 a ton for batch.

By corollary savings, he reasoned, if he could refine the glass fiber in a more precise manner than was being done, he could use less material of a higher quality than his competitors, and the unit weight would be reduced accordingly.

Today, a package of fiber glass is compressed for shipment on a four-to-one basis: the dealer can make one trip to the site of a new house-building job with ¼ of the weight and bulk. He used to make four trips. One-quarter as much paper is needed to package the fiber glass insulation; shipping costs, warehousing, and all similar costs are reduced accordingly.

All this means that it was soon possible for the company to spend more money melting the glass and preparing the batch and still be able to deliver a less expensive, but superior, product.

Throughout his illustrious career in the development of fiber glass, Games Slayter has frequently exhibited his sound reasoning and unique ability not only to develop 125 patents but also carry them through to successful end products.

Now, as vice president in charge of research and development, he is personally responsible for the Pioneering Laboratory of Owens-Corning Fiberglas Corp., situated on a farm near Newark, Ohio. He is continually pursuing new ideas and new products associated with glass.

For outside interests he has long engaged in experimental farming and animal husbandry; his curiosity and scientific searching is constantly on the march.

Every one in the glass manufacturing field who has met and worked with Dr. Slayter recognizes him as a man of stature and accomplishment.

We join his many steadfast friends and associates in applauding this latest honor which has been bestowed on a great man who deserves it so very much.

The Making of a Glass Man

By DR. GAMES SLAYTER

Vice President, Research and Development
Owens-Corning Fiberglas Corp.

Editor's Note: The acceptance speech of Dr. Slayter on the occasion of his receiving the Toledo Award is such an interesting and personal history of fiber glass that we are publishing it in full.

I DON'T KNOW OF ANY HONOR which could come my way t at I would appreciate more than I do the 1959 Toledo Glass and Ceramic Award being presented me by the Northwest Ohio Section of The American Ceramic Society.

It is particularly valuable because it comes from people who have, to a large measure, worked with me. It is also a great distinction to be listed with Francis C. Flint, the late Donald E. Sharp and J. T. Littleton, who are the three former recipients of the Award.

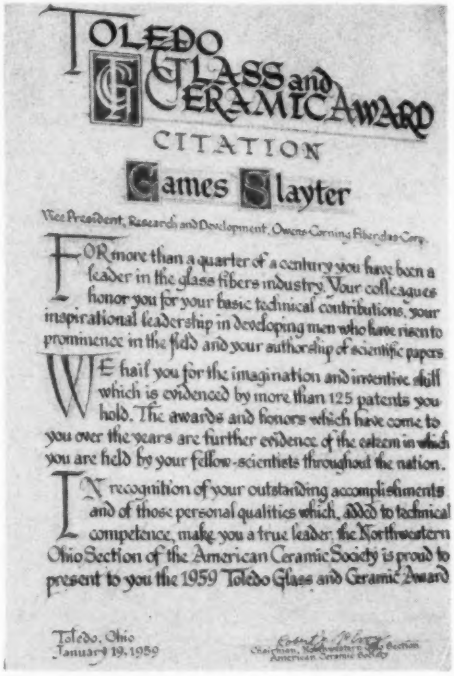
In thinking about making a talk which would be interesting and, perhaps informative, and also as I puzzled as to why I had received the Award, I came to the conclusion that the Award was not coming to me alone, but to all those who had contributed to my education and training in the technology of glass. As I thought about this, my introduction to the glass business came to mind.

I had been particularly interested in the insulation of houses and had attempted to find some available material to be used in insulating houses. Mineral wool, as it was then known, was 60 per cent slugs and weighed 8 lbs./cu. ft., and when you tried to blow it through a hose, it stopped up in the bends. Cork could be blown into the walls of buildings readily, but it was not available in sufficient quantity to insulate very many houses. Ground-up corn cobs turned out to be a pretty good material when fireproofed by the addition of a small percentage of gypsum.

At that time I was working with a patent attorney by the name of Charles B. "Bunn" Belknap. He became my first contact with the glass industry as he was also patent counsel for the Owens-Illinois Glass Company.

It occurred to me about that time (1929 or 1930) that if you could melt some minerals and whip them up into a fluff like egg white and solidify it that way, the resulting glass foam would be a wonderful insulating material.

I did not know that I was thinking about glass, until Mr. Belknap pointed out to me that this combination of molten materials was actually glass. He suggested that, if I was willing, he would like to make an appointment for me to meet Mr. W. E. Levis, Mr. U. E. Bowes, and Mr. R. H. Barnard of Owens-Illinois Glass Company, Toledo, Ohio. I consented.



TOLEDO GLASS and CERAMIC AWARD

CITATION

Games Slayter

Vice President, Research and Development, Owens-Corning Fiberglas Corp.

FOR more than a quarter of a century you have been a leader in the glass fibers industry. Your colleagues honor you for your basic technical contributions, your inspirational leadership in developing men who have risen to prominence in the field and your authorship of scientific papers.

WE hail you for the imagination and inventive skill which is evidenced by more than 125 patents you hold. The awards and honors which have come to you over the years are further evidence of the esteem in which you are held by your fellow-scientists throughout the nation.

IN recognition of your outstanding accomplishments and of those personal qualities which, added to technical competence, make you a true leader, the Northwestern Ohio Section of the American Ceramic Society is proud to present to you the 1959 Toledo Glass and Ceramic Award

Toledo, Ohio
January 19, 1959

Chairman, Northwestern Ohio Section
American Ceramic Society

Mr. Levis, backed up by Mr. Belknap, Mr. Barnard and Mr. Bowes, inspired me with the possibilities of glass. They explained to me how a carload of milk bottles sold for the same price per ton as steel rails, and a ton of milk bottles is a great many finished, manufactured articles—beautiful, and accurate in capacity. The principal things made out of glass were containers, scientific instruments, laboratory ware, sheet glass, and table ware. The wonderful properties and low cost of this material should make it valuable in many other uses not yet developed. There was a great opportunity for a young man, or young men, who would undertake to develop new uses for glass, and Owens-Illinois Glass Company was willing to back such a development program.

As a result, I went to work for Owens-Illinois Glass Company on April 18, 1931, as a consultant under contract to give one day per week of my time to them. Then started my education in the properties and possibilities of the wonderful material which we call "glass." New things to make out of glass, occurred to us rapidly. It is impossible to say who had what idea first, since the whole group was so enthusiastic. In rapid succession came such things as glass foam, air filters, glass block, double glazing, glass in fiber form, flower pots, wall tile and many other things. (*Continued on next page*)

Fred Chambers (left), chairman of the Award Committee; Robert J. McEvoy, Chairman, Northwestern Ohio Section, American Ceramic Society; and Dr. Slayter, during presentation of Fourth Toledo Glass and Ceramic Award.

The day I came to work, Mr. Belknap told me that when he came into the industry as a young patent attorney, Mr. Whittemore, patent counsel for Mike Owens, told him he wanted to give him two pieces of advice. One was, "Don't let anyone ever tell you what glass will do in a given situation unless he has tried and tested it," and the second was, "Don't let Mike Owens bulldoze you."

"Now," Mr. Belknap said, "I would like to give you two pieces of advice: First, don't let anyone ever tell you what glass will do in a given situation unless he has tried and tested it, and secondly, don't let *anyone* bulldoze you." I have found this advice to be very valuable and would like to pass it on to any young technicians in the glass business.

We started our activity at Evansville, Indiana. It was hoped that we would develop something new in time to keep from having to close that plant, but we soon found that the development of new things did not move that rapidly. So, after carrying on the work there from April to December, 1931, the Evansville Plant had to be closed because of lack of business. Our activity was moved to the Columbus, Ohio, Plant.

Mr. Levis and Mr. Belknap did a very wise and helpful thing for me at the time we moved to the Columbus Plant. A fine old gentleman by the name of Sam Cochrane, "Sunny Sam," was retired General Factories Manager of Owens Bottle Company and a brother-in-law of Mike Owens. "Sunny Sam" was employed by Mr. Levis to work with me and teach me some of the history, tradition and lore of the glass business. This was a most valuable thing to a young chemical engineer learning about glass.

"Sunny Sam" was without formal technical education. He was a man of great innate intelligence and the ability to convey his knowledge to others. He told us many anecdotes about Mike Owens and his problems during the development of the several glass processes in which he was at various times involved. Sam allowed us to test him against the pyrometers—he didn't believe in them much—in judging furnace temperature, and he was just about as accurate as the pyrometers we had in those days.

Soon after we were at work in Columbus, Mr. Barnard showed up one day in company with Mr. Carl R. Megowen, and I was told that Mr. Levis had asked Mr. Megowen to give me some instruction in regard to basic accounting. In about one day's time I was given the equivalent of a two-semester course in accounting, which of course, I did not absorb. With certain follow-up in training, I soon had a notion of what the proper use of accounting could do in directing development programs.

Not long after that Mr. Harry R. Winkle showed up in my laboratory, and I want to say that no one in charge of an important development program has ever had more friendly cooperation from the financing and accounting end of a business than I have always enjoyed in my relations with Mr. Winkle. He has always taken an active interest in the development programs of the company and has contributed continuously to our development programs by giving us good economic direction.

No one with a technical education could have been more ignorant than I was about glass. I had graduated in Chemical Engineering from Purdue University and knew something about refractories and how they were used in the metallurgical industry, but I just wasn't conscious of glass, as many people aren't conscious of it. So, one of the first things Mr. Barnard and Mr. Bowes arranged was for me to spend considerable time at Alton, Illinois, with Mr. Joe Wright and Mr. E. W. Summers. I feel that my knowledge of glass, what it is, how it is melted, what the temperature problems are, and what the raw material problems are were basically given to me by these two gentlemen.

While making the train trip from Paris, Illinois, to Evansville, Indiana, one evening, I met Mr. Harold Boeschenstein, the vice president and sales manager of Owens-Illinois Glass Company. He spent the evening in the diner, going through the *Saturday Evening Post* and explaining to me the good and bad characteristics of the advertising and the merchandising value of one ad as compared to another.

If this were an account of the development of the Fiberglas business rather than an account of my training in the technology of glass, it would be the story of Harold Boeschenstein, and it would require a talk entirely devoted to this one man if I were to describe adequately the accomplishments of this business genius.

Many fine ideas for products and processes have never been developed because the people controlling the business were not willing to take a chance. No director of

(*Continued on page* 108)

Some Aspects of

Heat Recovery in Glass Furnaces

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Effects of Heat Recovery

There is an enormous heat loss in the gases leaving high-temperature operating furnaces, like those used in glass melting—unless some system of heat recovery is utilized. Fig. 1 shows the percentage heat loss at various waste gas temperatures leaving the furnace. At 2500°F, for example, the heat in the waste gases, is 62 per cent of the heat input for a natural gas fired furnace.

The most obvious use for this heat is to pre-heat air for combustion in the furnace. For every cubic foot of gas burned, approximately 10 cu. ft. of air is required, and for every degree of pre-heat which can be given to this air, there is a direct gain to the furnace in the form of hotter products of combustion. "Hotter products of combustion" means more heat is available above the operating temperature of the furnace.

Fig. 2 shows the increase in heat available to work in

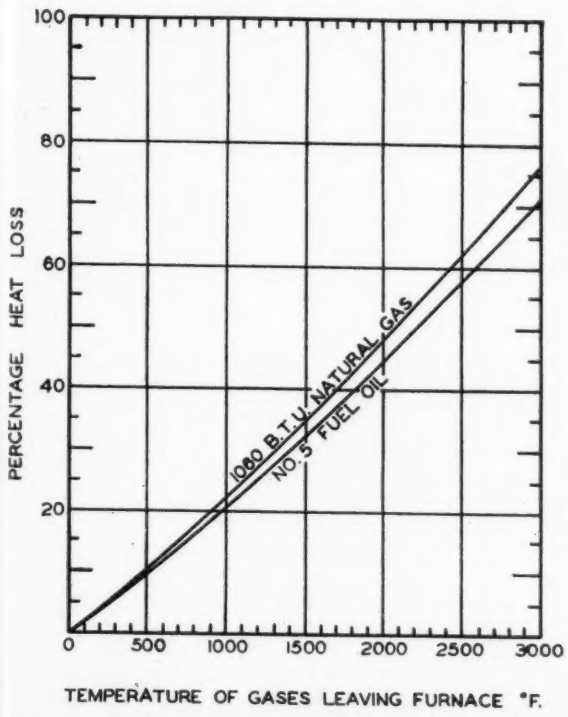


Fig. 1. Heat loss in furnace waste gases.

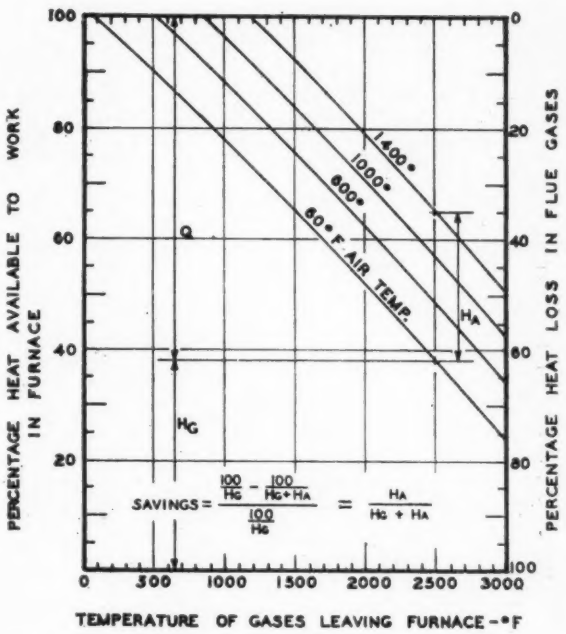


Fig. 2. Relationship between heat available and air pre-heat.

the furnace for various air pre-heat temperatures. It will be noted that when the gases leaving a direct-fired furnace are at 2500°F the heat available to work is only 33 per cent of the fuel input. If we pre-heat the combustion air to 1400°F the heat available to work becomes 65 per cent of the fuel input.

What does this mean in terms of fuel savings? This can be calculated by a method based on the procedure outlined by W. Trinks in "Industrial Furnaces," Volume I. From a further study of Fig. 2, Q is the percentage of the heat of combustion lost in the flue gases and H_g is the percentage of the heat of combustion utilized in the furnace with no air pre-heating. Then $Q + H_g$ represents the total heat produced by the combustion of the fuel, or 100 per cent. H_a is the percentage of heat of combustion returned to the furnace by pre-heating the air used for combustion. Then $H_g + H_a$ is the percentage of heat of combustion utilized in the furnace with air pre-heating. Hence, the fuel consumption is propor-

Presented at nineteenth Conference on Glass Problems, Ohio State University, Columbus, Ohio, December 4 and 5, 1958.

tional to:

$$\frac{100}{H_g} \text{ and } \frac{100}{H_g + H_a}$$

and the relative fuel savings (saving divided by the quantity used before saving) becomes

$$\frac{\frac{100}{H_g} - \frac{100}{H_g + H_a}}{\frac{100}{H_g}} = \frac{H_a}{H_g + H_a}$$

Using the set of conditions above of 1400°F air and 2500° flue gas, the fuel savings equals

$$\frac{27}{38 + 27} = .415 \text{ or } 41.5 \text{ per cent}$$

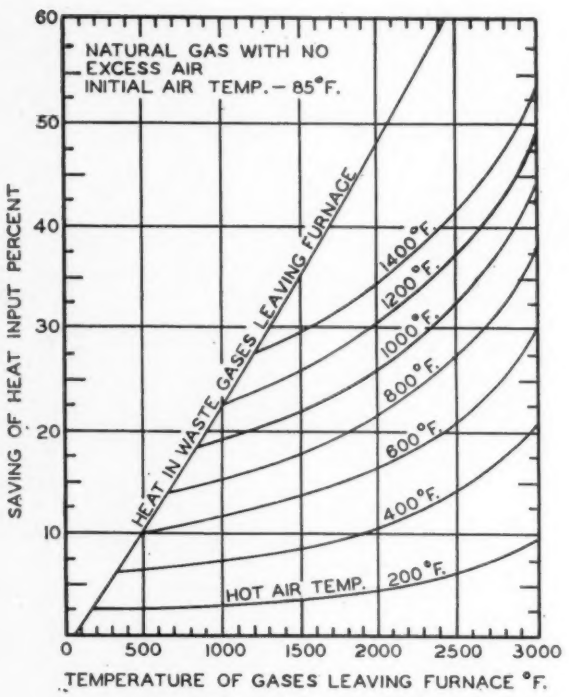


Fig. 3. Saving by recuperation.

It is evident from Fig. 2 that the higher the temperature of the flue gas, the greater Q becomes and the smaller H_g becomes. A decrease in H_g in the fuel savings formula gives an increase in per cent of fuel savings.

Figure 3 shows the fuel savings, as indicated by the above formula, for several air pre-heat temperatures and flue gas temperatures for a Natural gas fired furnace using no excess air. You will note that furnaces with high temperature flue gases offer the greatest potential for fuel savings.

The following additional improvements in the furnace performance, which are important but rather intangible, do not show up on a fuel savings chart.

1. The amount of furnace combustion space required is reduced, thereby providing increased furnace melting capacity. Improved refractory life is possible if production is not increased.
2. The furnace operating conditions are more easily controlled, due to the higher flame temperatures available which give faster response to fuel adjustments.

Heat Recovery Systems

Now that we have established that both fuel savings and improved furnace performance can be obtained by preheating the combustion air, let us consider some of the various systems used for recovering heat from the furnace flue gases. Regeneration is the most commonly used method for heat recovery and is generally adaptable to most furnaces. The main drawbacks of regenerative firing are the periodical reversal of the flow of gases through the furnace system and the restrictions which are imposed on the design and operation. Small melting units, in particular, have physical limitations which make the use of regenerators impractical. For these applications, the consideration for heat recovery are reasonably limited to the use of recuperators.

Recuperative pre-heating of combustion air has been practiced with refractory units for many years, with varying degrees of success. Some of the problems encountered such as excessive leakage, clogging and cracking of the tile, did not provide trouble-free operation.

Attempts to overcome the shortcomings have been made by combining metal and refractory in the recuperator construction. The metal was to prevent the leakage, and the refractory lining protected the metal against burn out. Differential expansion and construction diff-

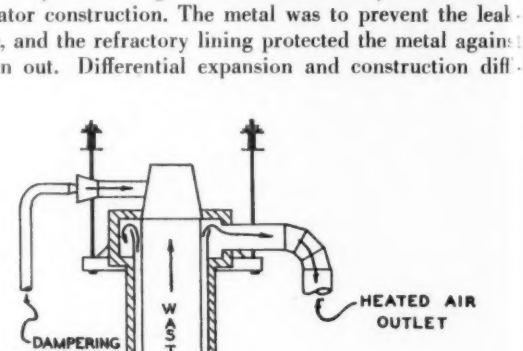
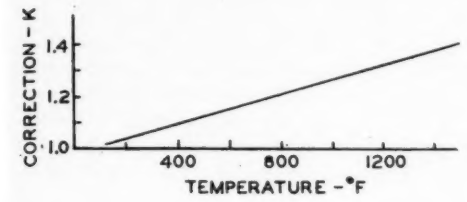


Fig. 4. All-metal recuperator.

culties, coupled with low rates of heat transfer due to the air gap between the metal and refractory did not make this method of construction very desirable.

With the advent of improved heat-resisting alloys, metallic recuperators have become very durable and able to withstand severe operating conditions. If they are designed to prevent secondary stresses and to give high coefficients of heat transfer on the air side, long life with little maintenance can be obtained.

There are many tubular-type metallic recuperators



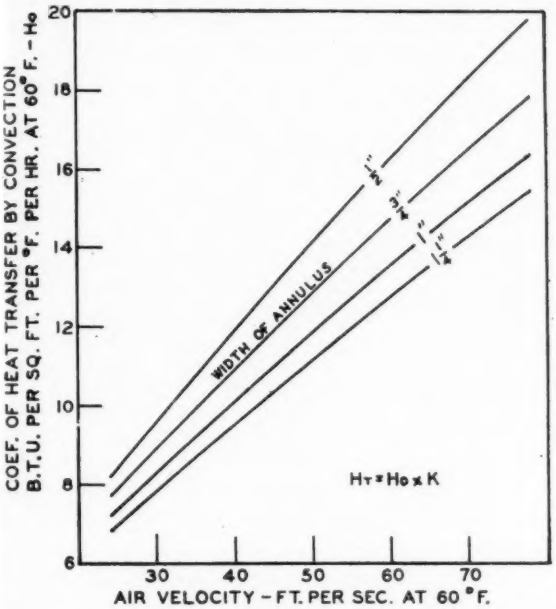


Fig. 5. Heat transfer between air and rough metal annulus —H_T.

that have been developed, ranging from the simplest form of tube bank in the furnace flue to the most elaborate patented designs. In general, each design attempts to obtain a high heat recovery without failure which may be caused by:

a) Cracking or breaking of the metal from stresses caused by thermal expansion.
b) Scaling or burning of the metal from overheating.
c) Creep deformation caused by continuous loading at elevated temperatures.

Build up and clogging in the flue gas passages is a problem for any heat recovery system applied to glass-melting furnaces, and the design should minimize or prevent this occurrence.

A recuperator designed and developed by H. Escher of the Australian Iron and Steel Ltd., has overcome

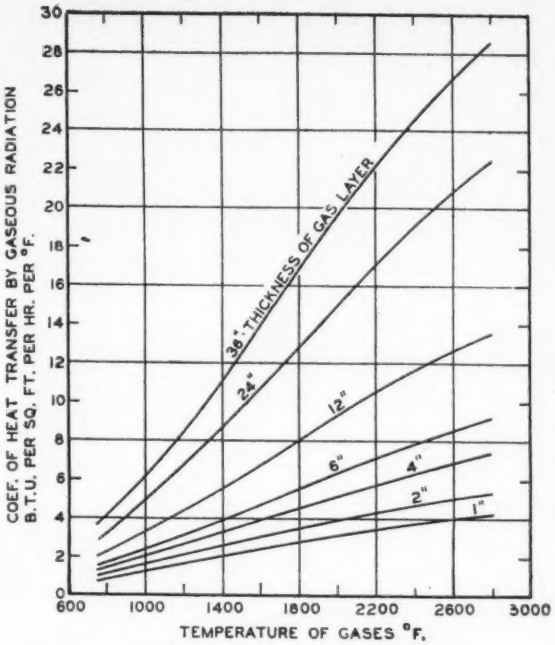


Fig. 6. Heat transfer by gaseous radiation from gases containing 12 per cent CO_2 and 12 per cent H_2O by volume.

many of the difficulties inherent in other recuperators. Adaptation of his design to glass-melting furnaces and subsequent improvements have virtually removed the "black cloud" that has hung over recuperators in the glass industry.

The recuperator is an all-welded construction consisting of two concentric cylinders which form a narrow annulus between the inner and outer tubes, as shown in Fig. 4. These tubes, or cylindrically shaped shells, are connected at each end with header boxes which also form the air inlet and outlet connections. The waste gas from the furnace passes upwardly through the unobstructed center tube and transfers heat, mainly by radiation, to the inner surface of the tube.

The air to be heated flows in the annulus and is maintained at high velocities to give even distribution and high rates of heat transfer by forced convection. The range of annulus widths is from 0.2 to 2.0 inches, and narrower gaps being used on tubes of small diameter and the wider gaps on long recuperators of large diameter. Accurate spacing is maintained by longitudinal fins welded to the inner tube. The air may have parallel, or counter, flow with respect to the flow of the waste gas, depending on application.

It should be noted at this stage how the design has accommodated the requirements for good heat transfer. Air absorbs heat by convection only and, as shown in Fig. 5, the heat transfer increases with velocity; therefore, the high velocity in the annulus is a desirable feature. The products of combustion give up heat mainly by radiation from the CO_2 and water vapor, and since gaseous radiation increases with the thickness of the gas layer as shown in Fig. 6, the large path for the waste gas is also a desirable feature.

(*Continued on page* 102)

Fig. 1. Mold Set No. 1. Blank Mold. Outer surface. X100

Investigation of Materials for Glass Container Molds

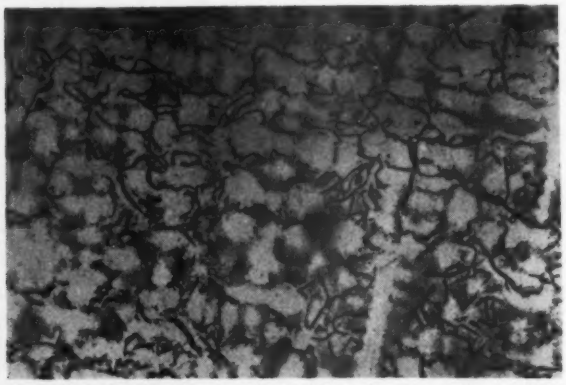


Fig. 2. Mold Set No. 1. Blank Mold. Inner surface. X100

Fif. 3. Mold Set No. 1. Baffle. Inner surface. X100

• THE CONTINUING RESEARCH PROGRAMS of Emhart Manufacturing Company are directed toward improvements in the glass container manufacturing process. The first article of this series discussed the microstructure of cast-iron molds. A study of European molds indicated that microstructure is a very important determinant of mold life.

A fine graphitic formation was shown to be highly desirable at the working surface of the mold. Absence of this surface condition during normal operation allows oxidizing gases to penetrate easily around the graphite. The result was found to be scaling and foreshortened mold life.

In the present study, a chemical and metallurgical examination was made of two sets of typical glass container molds that had seen good service in the United States. The molds studied were worn out from service in a commercial glass plant. It is estimated they had produced about 4,000 to 5,000 gross of containers. A good life span for both a blank and blow mold is considered to be about 5,000 gross, provided the molds have been well cared for and kept in clean condition. This applies to molds using either the blow-and-blow or the press-and-blow process.

Mold Set No. 1

A chemical analysis of the blank mold of Set No. 1 showed the following composition:

Composition Per Cent by Weight

C total	C combined	Si	Mn	P	S	Ni	Cr	Mo
3.00	0.45	2.00	0.53	0.17	0.10	0.10	0.10	0.18

Fig. 4. Mold Set No. 1. Baffle. Outer surface. X100

Fig. 5. Mold Set No. 1. Blow Mold. Inner surface. X100

By the Technical Staff
Emhart Manufacturing Company
Hartford, Connecticut

PART TWO

Specimens were taken at different parts of the blank mold and of the corresponding baffle in order to prepare microsections. On the outer surface of the mold, a relatively coarse graphite was found, as shown in Figure 1, while on the inner working surface the graphite was substantially finer, as shown in Figure 2. Besides globular cementite, small amounts of phosphide eutectic, manganese sulphide, and titanium nitride could be observed. Near the working surface the Brinell hardness of the mold was 140, while inside the mold it varied from 128 to 135.

The baffle for this mold was made from a preshaped casting having the approximate outline of the baffle. An analysis of the working surface showed a graphite eutectic typical of a high solidification rate in a ferritic matrix which showed small amounts of very fine globular cementite, as shown in Figure 3. On the other hand, the outer surface of the baffle predominantly showed flake graphite which was surrounded by coarse ferrite. In addition, the matrix contained finely lamellar pearlite which, in part, showed a tendency toward a globular formation, as shown in Figure 4. The Brinell hardness of the baffle at the working surface varied from 138 to 150, whereas on the pearlitic surface it varied from 175 to 180.

A chemical analysis of the blow mold of Set No. 1 gave the following composition:

Composition Per Cent by Weight

C total	C combined	Si	Mn	P	S	Ni	Cr	Mo
3.02	0.40	2.35	0.54	0.16	0.09	0.11	0.08	0.20

(*Continued on page* 96)

Fig. 10. Set No. 2. Blow mold. Near inner surface. X100

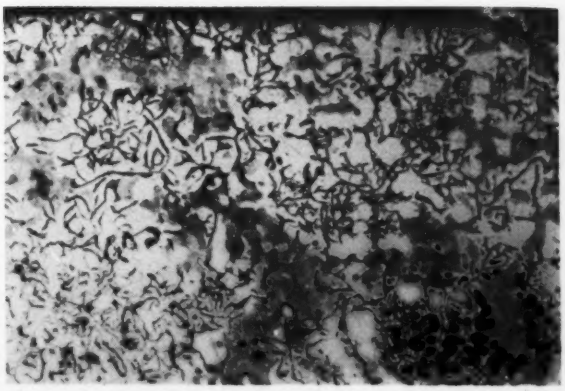


Fig. 9. Mold Set No. 2. Blow Mold. Inner surface. X100

Fig. 8. Mold Set No. 1. Bottom Plate. Outer surface. X100

Fig. 6. Mold Set No. 1. Blow Mold. Outer surface. X100

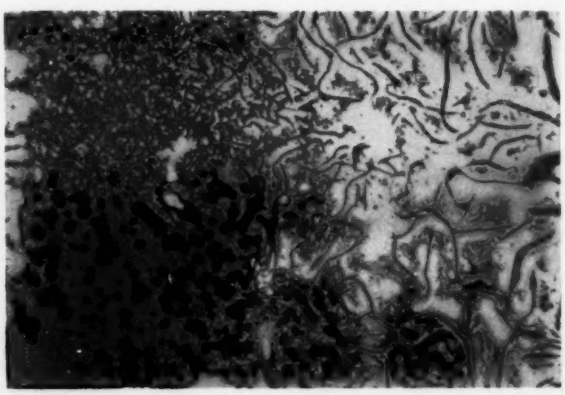


Fig. 7. Mold Set No. 1. Bottom Plate. Inner surface. X100

Stephen Jeckovich

Robert M. Hainsfurther

E. Jennings Hazen

Merle M. Eakins

HEGG NAMED BY JOHNS-MANVILLE

Clinton F. Hegg has been appointed assistant to the vice president for sales of Johns-Manville Corporation as part of the company's plan to expand fiber glass markets in the United States, Canada and overseas. Mr. Hegg, formerly vice president and general sales manager of L-O-F Glass Fibers Company which J-M recently acquired, will act as liaison and consultant to six Johns-Manville Corporation operating divisions on fiber glass sales problems. Sales of J-M fiber glass products are currently at the rate of $26 million a year.

H-W RESEARCH CENTER

Early last month Harbison-Walker Refractories Company opened its new Garber Research Center, named in honor of Earl A. Garber, president. The Center has approximately 45,000 sq. ft. of floor space and houses complete laboratories for instrumental research and a pilot plant for applied research.

According to Raymond E. Birch, director of research, both fundamental and applied research will be stressed, the latter including development of raw products still in the pilot plant stage for which Harbison-Walker foresees future industrial demand.

The company's research activities had previously been centered in the Hays, Pa., laboratories which will now be used exclusively for a broadened quality control program.

Formal dedication is tentatively scheduled for the early part of June.

NEW PLANT MANAGERS FOR PPG

Robert M. Hainsfurther has been appointed general manager of plate glass manufacturing plants for Pittsburgh Plate Glass Company, with headquarters in the Pittsburgh general office. He had formerly been manager of the PPG Cumberland, Maryland, plate glass plant.

John B. White, former assistant manager, succeeds Mr. Hainsfurther as the Cumberland plant manager. Charles S. Cusick, superintendent of grinding and polishing at Ford City, replaces Mr. White as assistant manager.

Stephen Jeckovich, formerly assistant plate glass production engineer in the Pittsburgh general office of Pittsburgh Plate, has been appointed manager of Works No. 1, Creighton, Pennsylvania, succeeding T. Karl Gregorius who has retired after 36 years of service.

Paul C. Lawson, assistant manager, fabricating department of Works No. 1, has become assistant manager, succeeding Harry F. Myers, who has retired after almost fifty years with the company.

E. Jennings Hazen, assistant manager of Works No. 4, Ford City, is now manager, replacing J. George Brown who retired after 48 years.

Merle M. Eakins, assistant manager, has become manager of Works No. 9 at Crystal City, succeeding Robert M. Conley, who has had 39 years of service. Frank V. Breeze has been named assistant manager of this plant.

CORHART NAMES DIRECTOR

Charles D. LaFollette, financial vice president of Corning Glass Works, has been elected a director of Corhart Refractories Company, Inc., succeeding the late Dr. William C. Taylor.

TO MANAGE HAZEL-ATLAS PLANT

George R. Moore has been named manager of Continental Can Company's Hazel-Atlas Glass Division plant at Clarksburg, West Virginia. Having had 28 years of experience in the glass field, he was most recently with Owens-Illinois in Charleston, West Virginia.

ARMSTRONG EXPANDING GLASS PLANT

Armstrong Cork Company is now expanding its Dunkirk, Indiana, glass plant, a project which will ultimately increase production capacity by approximately 50 per cent.

Facilities to be installed in the new plant will include a large glass-melting furnace, forming machines, lehrs, carton and packing equipment, and increased mold-making equipment.

This will be the largest expansion at Dunkirk since the company bought the plant in 1938, according to Joseph C. Feagley, vice president and general manager of Armstrong's glass and closure division, and follows by less than a year another major expansion there which included new, modern packing, inspection and carton assembly facilities.

Armstrong's glass and closure division operates other plants at Millville and Keyport, New Jersey; Lancaster, Pennsylvania; and Dallas, Texas.

NEW GLASS PROCESS ANNOUNCED BY PILKINGTON

Pilkington Bros., Ltd. has announced a new method of manufacturing high-quality flat glass, which, according to Sir Harry Pilkington, chairman, is the most important glass-making advance of the century.

The new development, called "float" glass, is the result of seven years of intensive research amounting to $11,200,000. The company is producing limited quantities of flat glass by the new method which is said to combine the best properties of plate glass and fire-finished sheet glass "to give a distortion-free product without the grinding and polishing hitherto necessary."

The process has been fully patented by Pilkington and briefly consists of drawing a continuous ribbon of molten glass about 100 inches wide from the furnace and floating it on a surface of molten metal at a controlled temperature.

A. P. GREEN EXPANSION

The A. P. Green Fire Brick Company is planning to construct a new $2-million plant for manufacturing basic refractories at Tarentum, Penna. The Tarentum plant will produce a full line of basic refractories consisting of magnesite, magnesite-chrome, chrome-magnesite, and chrome.

William G. Malone, superintendent of service departments, at the main office in Mexico, Missouri, will become plant manager at Tarentum, and Ray A. Witschey is also being transferred to the new plant as sales engineer.

BIGGERS ON J-M BOARD

John D. Biggers, chairman and chief executive officer, Libbey-Owens-Ford Glass Company, has been elected to the board of directors of Johns-Manville Corporation.

KAHLE ENGINEERING MOVES

Kahle Engineering Company has moved to new and enlarged plant facilities located at 3322 Hudson Avenue, Union City, N.J. Several new high-precision machines have been installed for maximum efficiency in making its line of precision machines.

GORDON RETIRES AS V.P., SOLVAY

Lester B. Gordon retired on December 31 as vice president, Solvay Process Division, Allied Chemical Corporation. He began selling Solvay products in 1915 and ten years later was appointed manager of the Chicago Sales branch. Mr. Gordon moved to New York in 1930 as northern division manager, becoming assistant director of sales in 1937. He had been vice president since 1951.

His work will be continued by Arthur Phillips, Jr. who was recently appointed vice president.

Lester B. Gordon

Ernest M. Hommel (right), president of the O. Hommel Company, Pittsburgh, and H. R. Urbach, treasurer and general manager, admiring each other's service pins which were awarded during a ceremony in the company's new research center in December. Twenty-three other pins were awarded to other members of the company. Mr. Urbach received a 55-year service pin and Mr. Hommel, a 35-year pin.

FAIRMOUNT GLASS EXPANSION

Fairmount Glass Works, Inc. has completed the initial expansion phase of a $3-million program started in April of last year. The company states that its productive capacity is now 50 per cent greater.

GLASS DIVISION SYMPOSIA

Norbert Kreidl, chemical research director, Bausch & Lomb, is organizing a symposium scheduled for this Fall (1959) on "Radiation effects in Glass," which will be held at Galen Hall in the mountains near Wernersville and Reading, Penna.

The original idea for such a symposium was developed by a group of nuclear scientists who were brought together by Ray Hensler, recently Glass division program chairman.

Dr. Kreidl is inviting several outstanding investigators to introduce the subject of radiation effects by talks covering their areas of interest. These in turn will be followed by contributed papers on particular studies within the general field.

Other features of the meeting will be a program of general papers, and an informal Workshop on Strength Measurement. The Workshop will be under the leadership of Neill Brandt, Senior Fellow at Mellon Institute, and present division chairman.

Complete Symposia Schedule

Spring, 1959: Symposium on Behavior of Glass in the Viscoelastic Range. Howard R. Lille, Chairman, Corning Glass Works, Corning, N.Y.

Fall, 1959: Workshop on Strength Measurement Techniques. Neill M. Brandt, chairman, Mellon Institute, Pittsburgh, Penna.

Symposium on Radiation Effects, Norbert J. Kreidl, chairman, Bausch & Lomb Optical Company, Rochester 2, N.Y.

Spring, 1960: Symposium on Heat-Transfer Phenomena in Glass. C. L. Babcock, chairman, Owens-Illinois Glass Company, Toledo, Ohio.

International Meetings on Glass

VENICE: APRIL 16-18

An international meeting on the subject of glass, "Giornate del Vetro," will take place on April 16, 17 and 18 in Venice, Italy. There will be two sections, one for scientific and technological subjects, and the other, for economic and social topics.

Authors have been invited to present papers. The 3-day event is being sponsored by the Associazione Nazionale degli Industriali del Vetro, in cooperation with the Stazione Sperimentale del Vetro and the Societa Tecnologica Italiana del Vetro.

There will be a $10 (6000 lire) registration fee for the meeting and banquet for every one except authors who present papers. Hotel reservations may be arranged through the Tourist Agency S.A.T.T.I.S., San Marco 1474, Venice, Italy.

MUNICH: JUNE 29-JULY 4

The Fifth International Congress on Glass is being held this year in Munich from June 29 to July 4. Technical sessions will cover control techniques for production efficiency; furnace instrumentation; refractories; transmission of infra-red radiation through glass; and the strength of glass.

BROCKWAY RESEARCH CENTER

Brockway Glass Company is completing a central laboratory and research center at its main plant in Brockway, Penna. The new building will be staffed with twenty chemists, physicists, glass technologists, ceramic engineers and technicians, under the supervision of Dr. James P. Poole, director of research.

This research center will be the first step in a five-year program which will complete Brockway's plan for a general services plan. It will serve as a central control for the general engineering department, production staff, mold engineering department, central machine shop, central mold shop and the store room, as well as the central laboratory.

Brockway acquired the Demuth Glass Works, Inc., several years ago and now has plants in Indiana, New Jersey, Oklahoma and West Virginia, in addition to those in Brockway and Crenshaw, Penna. The new general services building will have facilities to serve all of these plants.

HAZEL-ATLAS SALES APPOINTMENTS

John M. Duncan has been appointed eastern regional sales manager and Walter D. Morton, New York district sales manager, for the Hazel-Atlas Glass division of Continental Can Company, with headquarters in New York.

PPG INTERNAT. DIVISION IN CUBA

Pittsburgh Plate Glass Company is establishing the central office of its international division in Cuba early this year, thereby taking advantage of the benefits offered by the interpretative tax measure enacted by the Cuban government last year. This tax decree permits United States corporations, or companies of any other nation, to control from a main office in Cuba all transactions originating or consummated outside Cuba without being subject to Cuban taxes on profits, or to taxes on dividends, capital, or excess profits.

DU PONT CERAMICS DIV. REORGANIZED

E. I. du Pont de Nemours & Company has reorganized the ceramics division of its electrochemicals department in order to devote more attention and effort to the company's line of products for the ceramics and glass industries.

Edward W. McGovern, formerly assistant director of sales, is now manager of the division. John M. Olsen, product manager for ceramics, will retain the responsibility for sales.

Manufacturing facilities of the division are in one section of the Perth Amboy, N.J., electrochemicals plant, and Kermit H. Ballard, senior supervisor in that section, is responsible for ceramics research.

ROBERT A. MILLER

Robert A. Miller, who retired in 1956 after 35 years as a glass development engineer of Pittsburgh Plate Glass Company, died January 11. He was closely associated with numerous products for specialized use in industry, military applications and transportation, and he had an important role in the company's glass division product development department.

DR. SAMUEL ZERFOSS

Dr. Samuel Zerfoss, chief of the refractories section, National Bureau of Standards, died December 19 as a result of injuries suffered in an automobile accident on the previous day. He joined the Bureau's staff in April, 1955 and five months later became section chief.

Prior to his association with the Bureau he had been in charge of the crystal growth and preparation section of the Naval Research Laboratory, and assistant professor of ceramics at Pennsylvania State College.

CHARLES S. REDDING

Charles S. Redding, chairman of the Board of Directors and former president, Leeds & Northrup Company, died January 2 after a brief illness. He joined the Morris E. Leeds Company as a draftsman in 1901, the company having been founded two years previously by Morris Evans Leeds. During the intervening years, Mr. Redding advanced from the position of salesman through that of associate sales manager, second vice president, treasurer, factory manager, and president (1939 to 1953). He had been chairman from 1953 to the present.

C. JUSTUS WILCOX

C. Justus Wilcox, managing trustee of the Libbey Estates and identified with Libbey-Owens Ford Glass Company for 60 years, died on December 27. He was 79 years old. He entered the accounting department of the Northwestern Ohio Bottle Co. in 1898 and became its office manager in 1906. The company was taken over by the Libbey interests, and Mr. Wilcox thereupon became secretary to Edward D. Libbey. In 1922 he was named a director of L-O-F Glass Company and most recently was a member of the executive committee of the board.

He was elected a director of the Owens-Illinois Glass Company in 1928.

Inventions and Inventors

Annealing and Tempering

Class annealing lehr. Fig. 1. Patent No. 2,822,645. Filed September 1, 1954. Issued February 11, 1958. Assigned to Surface Combustion Corporation by Harvey C. Weller and George F. Daley, Jr.

This invention relates to a glass annealing lehr, and, more particularly, to such lehr having a particular cooling arrangement which provides both radiant and convective cooling.

Referring to Fig. *1*, the lehr cooling apparatus *13* comprises a cooling air inlet duct *20* through which ambient air is supplied to the interior of a cooling box *21* having five solid walls *22* and a perforate plate bottom *23* which also forms the top surface of the cooling zone of the lehr. Air is introduced into the cooling box *21* through the duct *20* below the level of a series of horizontally disposed baffles *24* which, in the specific embodiment of the invention shown, divide the cooling box into an upper portion *43* and a lower portion *44* of approximately equal volumes.

Air is drawn from the duct *20*, through portions *43* and *44* and a duct indicated generally at *25*, and into a connecting duct *26* which is preferably under a slight vacuum. Dampers *28* and *29*, which can be manually adjusted by controls *30* and *31*, are provided, respectively, in the ducts *20* and *25*. It will be noted that, when a vacuum is applied to the connecting duct *26*, air is drawn thereinto from the upper portion *43*, of the box *21*, above the baffles *24*. This tends to draw air from the lower portion *44* of the box *21* through open spaces *32* between the baffles *24*.

When the damper *28* is in the position shown in Fig. *1*, ambient air passes readily through the duct *20* into the portion of the box *21* below the baffles *24*, with the result that air drawn through the duct *25* is replaced almost entirely by ambient air, with only limited flow of air from cooling zone of the lehr proper, which is indicated by the numeral *34*, into the cooling box. Ambient air drawn through the duct *20* into the lower portion *44* of the cooling box performs the principal function of cooling the perforate plate bottom *23* to a temperature at which such bottom is effective for radiant cooling of ware in the cooling zone *34*.

There were 8 claims and the following references.

United States Patents

1,828,904, Morton et al., Oct. 27, 1931 and 2,133,783, Merrill, Oct. 18, 1938.

Apparatus for improving lehr operation. Patent No. 2,848,845. Filed March 12, 1954. Issued August 26, 1958. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Armand J. Doumont.

The present invention includes means for automatically separating the broken portions of glass ribbon from the main body of the glass in order to minimize loss due to breakage. A series of high-speed rolls at the cool end

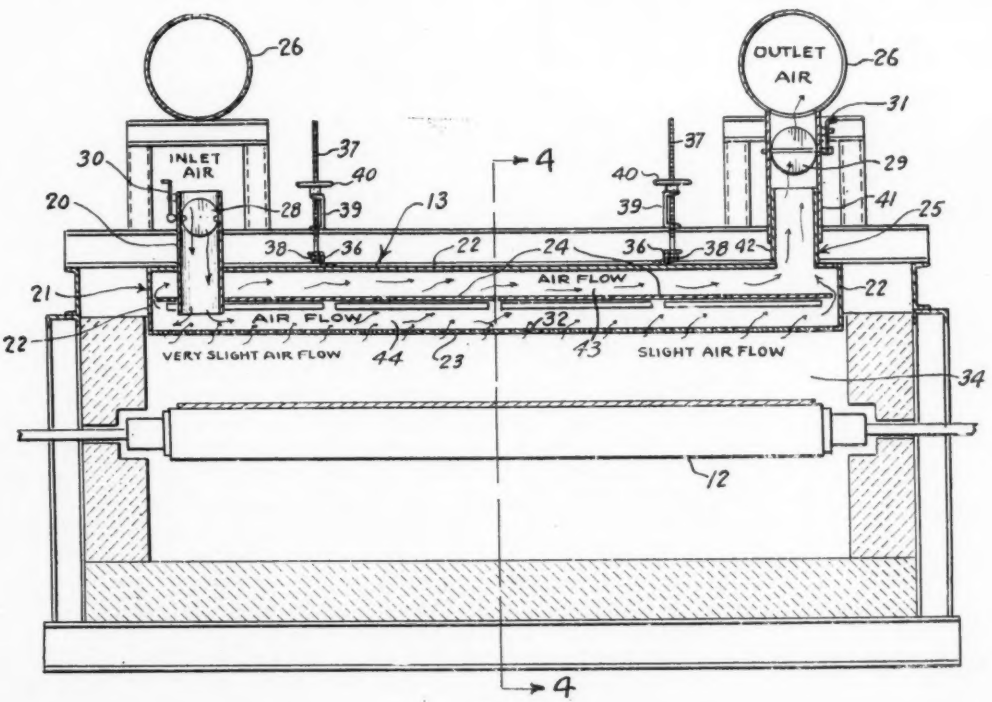


Fig. 1.

of the lehr accelerates this removal by speeding up the motion of the detached glass sections ahead of the main body of glass. This series of rolls may be speeded up when desired or, preferably, may be maintained at higher rotational velocities than the other supporting rolls for the conveyor which conveys the glass ribbon through the annealing lehr. The provision of high speed rolls at the cool end of the annealing lehr has resulted in a lessening of losses in square feet of rough rolled glass due to breakage in the lehr of between 90 per cent and 95 per cent.

There were 3 claims and the following references cited in this patent.

United States Patents

1,674,794, Peiler, June 26, 1928; 1,683,973, Heichert, Sept. 11, 1928; 1,728,538, Gentil et al., Sept. 17, 1929; 1,761,199, Drake, June 3, 1930; 1,792,653, Moxley, Feb. 17, 1931; 1,834,120, Callard et al., Dec. 1, 1931; 1,879,998, Sylvester, Sept. 27, 1932; and 2,235,359, Curry et al., Mar. 18, 1941.

Guide for glass bending molds. Patent No. 2,840,953. Filed December 14, 1951. Issued July 1, 1958. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Lloyd V. Black.

The present invention pertains generally to glass bending and more specifically to apparatus for positioning of glass sheets upon bending molds of the hinged type.

The glass sheet is placed between stops and moved against the heads of guides for accurate positioning of the glass sheet upon the mold and for initially holding the mold in open position. Should the glass sheet require adjustment relative to the mold to position accurately the bending glass upon the collapsing mold, the head portions of the guides may be suitably manipulated for retracting or advancing the head relative to a vertical plane through the mold face to which the guide is attached. The guide portion is attached to the mold by any suitable means, such as welding.

The assembled glass sheet, extended hinged mold, and mold frame are passed into and through a suitable heating furnace wherein the entire assembly is heated to a temperature sufficient to effect softening of the glass and bending thereof upon the mold.

There were 5 claims and the following references cited in this patent.

United States Patents

2,473,860, Cartun, June 21, 1949 and 2,551,606, Jendrisak, May 8, 1951.

Feeding and Forming

Glass Drawing Apparatus. Fig. 1. Patent No. 2,798,336. Filed February 24, 1953. Issued July 9, 1957. Two sheets of drawings. Assigned to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny & Cirey by René Pappens and Jean Paul Schrader.

The invention concerns the manufacture of glass articles, such as sheets, tubes, rods and the like by continuous drawing. It applies, more specially when those articles are to be coated, partially or wholly, with a

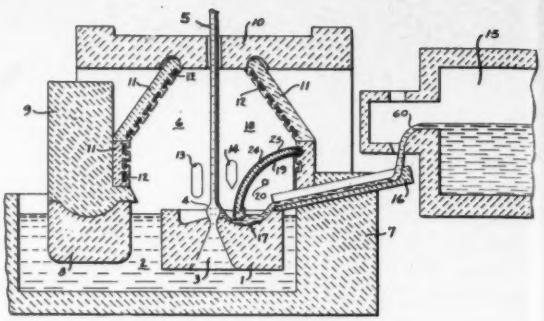


Fig. 1.

layer of colored, transparent or opaque glass or enamel while they are being drawn up.

In Fig. 1 of the drawing float *1*, placed in the glass bath *2*, is provided with the usual slot *3* through which the glass rises under the effect of the hydrostatic pressure of the surrounding glass while forming a bulb *4* which gives rise to the glass sheet *5* in a known way under the effect of a pull. The glass sheet *5* rises in a glass drawing chamber *6* which is delimited by the wall *7*, the weir *8*, the blocks *9*, *10* and refractory pieces *11* provided with grooves *12* containing electrical resistances which raise the compartment to, and maintain it at, a suitable temperature. The enamel *60* flows by gravity from a melting furnace *15* into a spout *16* as a thin stream which fills the longitudinal trough or basin *17* which is disposed in the upper part of the drawing float *1* parallel to the sheet *5*. The heating device is erected above said drawing float *1*. Said heating device comprises a vaulted metal plate *19* through which passes an electrical current brought in by the tubes connected to the side plates. These tubes are cooled by a water flow and electrically insulated by an insulating sheath, other outer tubes are used for supporting the device and putting it in its place.

When glass sheets are drawn up by the Fourcault process the invention can be applied to heat the upper surface of the drawing float or the surface of the glass bath on both sides of said sheet, thus preventing or, at least, delaying the beginning of devitrification, which is a well-known drawback of such process and which is caused by a protracted stagnation of the glass at a temperature which promotes devitrification.

There were 21 claims and 12 references.

Furnaces

Electric resistance melting furnaces. Patent No. 2,836,638. Filed May 21, 1956. Issued May 27, 1958. No sheets of drawings; none reproduced. Assigned to Didier-Werke A. G. by Eduard Steinhoff and Martin Grossmann.

This invention relates to electric resistance melting furnaces of the type in which the material to be melted flows downwardly between generally horizontal spaced electrically heated melting rods. The invention is particularly, although not exclusively, applicable to electric resistance furnaces for the melting of quartz sand into fused quartz.

According to the present invention each heating rod is screened from direct contact with the material being

(*Continued on page* 109)

cool cracker...

The "chill wafer" – that previews the performance of irons specified by customers—is a standard operation in production at Overmyer Mould Company's Foundry. Supervised by the metallurgist, this chill test determines the densification of the metal, pretests capabilities of alloy mixtures compounded for each particular customer's requirements, and indicates reaction of each batch of iron under operating conditions. It's a typical Overmyer service . . . to assure customer satisfaction . . . to contribute to the progress of the glass industry.

Overmyer Mould Company, Inc., Winchester, Indiana; Greensburg, Pennsylvania and South Gate, California.

Influence of Reaction Products on Reaction Between Water and Soda-Lime-Silica Glass

• THE MECHANISM OF THE REACTION between water and glass is not a simple one. As soon as the reaction begins, reaction products enter the system and become reactants. The accumulating effects, either accelerating or inhibiting, of these products determine, to a large degree, the course of the reaction between water and glass.

In a previous study the reaction products from water and a soda-lime-silica glass were identified as sodium metasilicate, calcium metasilicate, and metasilicic acid. The effects of these reaction products on the reaction between water and soda-lime-silica glass were investigated further in the work reported by Wang and Tooley in the December, 1958, issue of the *Journal of the American Ceramic Society*.

In this study, the reaction products from water and glass were employed as reactants in a series of reactions with glass. Each reaction product was used individually to react with the soda-lime-silica glass. The rates of these binary reactions combine to reveal the influence of these reaction products, collectively, on the reaction between water and soda-lime-silica glass.

The composition, on weight basis, of the glass used was SiO_2 74 per cent; Na_2O, 14 per cent; and CaO, 12 per cent. The procedures adopted for the preparation and exposure of the samples for the durability tests were the same as The American Ceramic Society Tentative Method No. 1.

A fresh glass sample was used for each reaction. Ten-gram glass samples, after digestion in 50 ml. of attacking solution at 90° ± 0.5°C. for a definite period of time, were filtered through a screen. The sodium, calcium, and silicon contents of these extracts were determined quantitatively.

Examination of the data obtained brought out the following points:

(1) A solution of sodium metasilicate reacted with glass and caused greater attack on glass than did water.

(2) A solution of calcium metasilicate caused about the same degree of attack on glass as did water.

(3) A solution of metasilicic acid showed a lesser degree of attack on glass than did water.

(4) The rate-controlling processes in the reaction between water and glass were the diffusion of cations and the extraction of silicates through the breakdown of the glass network.

(5) The rate of sodium ion diffusion was accelerated by the increase in, and was inhibited by the decrease in, the sodium ion concentration gradient between the solid and liquid phases.

(6) The rate of extraction of silicates was accelerated by the increased hydroxyl ion concentration in the solution.

(7) The extraction of calcium ions was due primarily to the process of glass-network breakdown.

(8) Processes of counter-diffusion of sodium, or calcium, ions existed when the sodium, or calcium, ion concentration gradient between the solid and liquid phases decreased.

Based on the results from this study, a qualitative description of the mechanism of the reaction between glass and water may be suggested as follows:

When glass is placed in contact with water, sodium ions diffuse through the glass into water. The diffusion of sodium ions is induced by the electric potential differences between the solid and the liquid phases, i. e. the sodium ion concentration gradients. The counter-diffusion of the sodium ions to the solid phase increases its reaction rate as the sodium ion concentration in the liquid phase increases.

Glass is made vulnerable to attack by the diffusion of sodium ions. The vacancy sites, which the diffused sodium vacated, can be replaced by hydrogen ions in an ion-exchange reaction or can be filled by sodium ions diffused from the inner glass layers.

A hydrogen ion has the same ionic charge as a sodium ion but a smaller ionic size. The replacement of sodium ions in the glass by hydrogen ions causes a weaker glass structure. Hydrogen ions in aqueous solution are always associated with water. Water molecules, thus brought into the glass structure, cause a swelling of the glass surface film. The swelling of the glass surface causes an expansion of interionic distances. Ionic bondings are consequently weakened, and glass surfaces become more reactive.

The diffusion of sodium ions from the glass interior activates the glass greatly, as the vacancies left are not readily refilled.

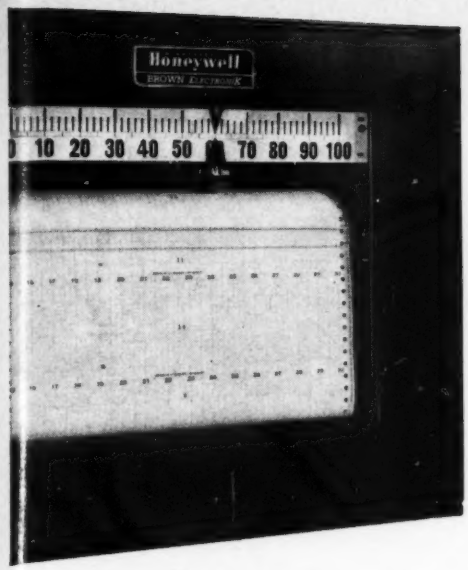
Some locales of the glass, weakly screened as the result of the substitution of hydrogen ions for sodium ions, develop a stronger positive pole, to which hydroxyl ions in the solution are attracted. Attachment of hydroxyl ions shifts the polarity toward the negative side, and because these hydroxyl ions have a coordinating influence on the cations in the glass, the SiO_4 tetrahedra become more easily separated from the glass. The consummate effects of these reactions bring about the eventual breakdown of the glass network at selective localities. The breakdown of the glass network on a macroscopic scale is evidenced by the flaking of glass articles. The network breakdown, as discussed here, is, however, considered only on the molecular scale.

The parts of the glass network extracted are essentially silicates. The extraction of silicates by water cannot be considered as merely a matter of solubility. A process of decomposition is involved.

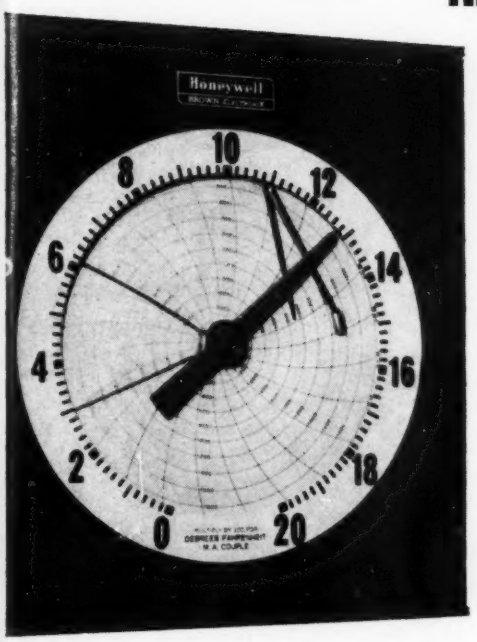
$$\text{Silicates} + H_2O = H_2SiO_3 + \text{cations} + OH^-$$

Hydroxyl ions in the solution further accelerate the decomposition of extracted silicates in water.

The extraction of silicon from the glass through the process of network breakdown must be accompanied by



NOW! no batteries or standard cells in *ElectroniK* potentiometers



The new Honeywell Continuous Voltage Stabilizer makes batteries, standard cells, and standardizing mechanisms unnecessary in new Brown *ElectroniK* circular or strip chart potentiometers. This new unit accurately regulates the D-C reference voltage supply to the measuring circuit. Standardization is no longer necessary.

The small compact stabilizer unit uses Zener diodes and an ambient temperature compensator to deliver a constant rectified voltage from line supply. This enables the instrument to respond to changes in the measured variable without interruption.

Each Continuous Voltage Stabilizer means more dependability, less maintenance, continuous attention to the measured variable, and still another reason why *ElectroniK* instruments are your best value in measurement and control. Get complete details from your nearby Honeywell field engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

the extraction of sodium and calcium ions in ratios at least equivalent to the glass composition. The extraction of cations in the glass may precede the extraction of silicon, as in the case of diffused sodium ions, or may accompany the extraction of the silicate ions; or the cation may be extracted as a part of actual silicate molecules.

For the glass studies in this work, the extraction of sodium ions can be considered as due to the diffusion process or to the process of glass-network breakdown; the extraction of silicon and calcium ions is due to the network breakdown.

Ions found then in the solution are SiO_3^{--}, OH^-, H^+, Na^+, and Ca^{++}. Interactions between ions are possible in many ways. The forward and reverse rates of these reactions are governed by the total ionic environment. The constitution of the solution therefore is governed by the reactions with the slower rates, such as reactions of the formation of silicates.

The amounts of sodium metasilicate, calcium metasilicate, and metasilicic acid in solutions, and their degrees of hydrolysis, determined the hydroxyl ion concentration of the solution. Their degrees of hydrolysis are not considered to be unity. The degree of hydrolysis for a 0.1 N sodium metasilicate solution was found to be 4.8 per cent; and the degree of hydrolysis for a 0.01 N solution was found to be 27.8 per cent. The hydroxyl ion concentration of the solution controls the rate of glass-network breakdown and the subsequent decomposition of extracted silicates in the solution.

As the reaction between glass and water proceeds, the decreased sodium ion concentration gradient slows down the diffusion of sodium ions from the glass. Mixtures of reaction products, i. e., H_2SiO_3, Na_2SiO_3, and $CaSiO_3$, tend to form buffer solutions and to stabilize the hydroxyl ion concentrations of the total solution. Increased H_2SiO_3 in the solution neutralizes some of the hydroxyl ions.

The amount of network breakdown gradually increases with time at a decreasing rate. The increase of silicate concentration in the solution begins to favor the formation of gels that form protective coatings on the glass and hinder further reaction. Eventually, the reaction between glass and water tends to slow down until little progress can be detected. It is important to realize that the apparent state of rest is not a true equilibrium state but rather one characterized by progressively slower attack, controlled by both the chemical and physical characteristics of the system.

Financial Reviews

LIBBEY-OWENS-FORD GLASS COMPANY

Net earnings after taxes for 1958: $21,445,309. Total L-O-F 1958 earnings equalled $4.10 per share compared with $5.36 a share in 1957. Sales for 1958 were $216,900,913; for 1957, sales were $237,199,069.

Factories have been operating at capacity in recent weeks owing to the heavy demand for plate and window glass in building construction and larger areas of laminated safety plate glass for automobiles.

A two-for-one stock split will be submitted by the directors to shareholders at the April 21 annual meeting.

FERRO CORPORATION

Earnings (unaudited) for 1958 are reported to be $1,988,000, or $2.76 per common share—up 18 per cent over 1957 earnings of $1,683,000, or $2.34 per share.

Consolidated sales for 1958: $56,300,000, or down one per cent from 1957 ($56,843,000).

The fiber glass division showed a comfortable profit last year after high initial costs of expanded facilities had been absorbed.

H. K. PORTER APPOINTMENTS

William D. Fullerton has been named assistant general manager, and William L. Fabianic, director of research of the refractories division, H. K. Porter Co.

Mr. Fullerton, previously assistant to the president, joined the company in 1957. Mr. Fabianic was recently vice president and director of research for Laclede-Christy Company which was consolidated into H. K. Porter Company, refractories division. He will handle research for all refractory products. Before joining Laclede-Christy in 1953, he was chief refractories engineer for Owens-Illinois Glass Company.

RUSSIAN GLASS AND CERAMICS PAPERS

Consultants Bureau Inc., 227 West 17th Street, New York 11, N. Y. has published 63 papers on Russian glass and ceramic research during 1956. Complete in English translations, the group is called "Soviet Research in Glass and Ceramics—1956."

It is published in three parts: Basic Science (38 papers); glass, glazes and enamels (10 papers); and cements, limes and plasters, refractories, miscellaneous (15 papers). All of the papers were orginally published in Russian chemical journals, and include all diagrammatic, tabular and photographic material.

O-C COMMUNICATION SYSTEM

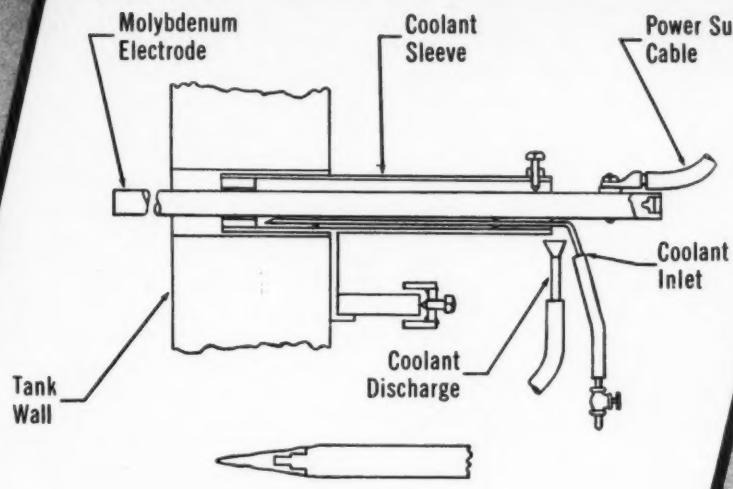
Owens-Corning Fiberglas Corporation has installed a high-speed communications system in order to improve service to customers and expedite internal communications. The 12,850 mile system links eight Fiberglas plants, 36 sales offices and 10 communications centers.

TRANSISTOR IMPORTS BEING WATCHED

Electronics manufacturers in the United States have become extremely concerned about the abrupt increase of Japanese imports of transistors and other commercial radio components. The electronic imports committee of the Electronics Industries Association, set up about a year ago, is studying the situation and is preparing a formal petition which may be submitted to the Office of Civil and Defense Mobilization early this year.

Robert C. Sprague, chairman of Sprague Electric Co., North Adams, Mass., is chairman of the electronic imports committee which has a membership of the forty U. S. transistor companies, as well as other radio component manufacturers. Also of concern to the committee are imports from Japan of other equipment such as condensers, amplifiers and regular vacuum-tube receivers.

Hot molybdenum ingots are forged into round billets, then further processed to make 1¼-inch diameter electrodes for glass melting furnaces using the Penberthy electrode assembly shown in the diagram.



Electrodes are joined by threaded ends to provide maximum use

Fansteel Molybdenum Electrodes

for electric melting...

here's what they cost:

Based on actual operational costs covering a production of 16,027 tons of flint glass over a period of several months, electrode cost amounted to *only 2½ cents per ton!*

here's what you get:

1. Increased production (10 to 30%)
2. Longer furnace wall life
3. Improved glass quality

FANSTEEL ELECTRODES CAN BE INSTALLED WITHOUT FURNACE SHUT-DOWN . . . are 99.9% pure, give off a colorless oxide, have high thermal and electrical conductivity, and high temperature strength. Write for more complete information.

K577

FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U.S.A.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during November, 1958, was as follows: *Flat Glass:* a preliminary figure of 22,700 given for November, 1958, indicated an increase of 87.6 per cent over the adjusted 12,100 reported for October, 1958. *Glass and Glassware, Pressed and Blown:* a decrease of 1.5 per cent is shown by the preliminary figure of 82,000 reported for November, 1958, when compared with the adjusted figure of 83,200 recorded for October, 1958. *Glass Products Made of Purchased Glass:* the preliminary figure of 14,300 given for November, 1958, indicates an increase of 0.7 per cent over the previous month's adjusted figure of 14,200.

Payrolls in the glass industry during November, 1958, were as follows: *Flat Glass:* an increase of 215.9 per cent is shown in the preliminary $12,940,123.20 given for November, 1958, when compared with October's adjusted $4,095,776.92. *Glass and Glassware, Pressed and Blown:* a decrease of 1.8 per cent is shown in the preliminary $31,046,638.28 reported for November, 1958, when compared with the previous month's adjusted $31,583,643.52. *Glass Products Made of Purchased Glass:* a preliminary figure of $4,674,465.74 was reported for November, 1958. This is an increase of 1.2 per cent when compared with the adjusted figure of $4,618,952.00 for October, 1958.

Glass container production: production based on figures released by the Bureau of the Census, Industry Division was 10,573,000 gross during December, 1958. This is a decrease of 8.3 per cent under the previous month's production figure, 11,533,000 gross. During December, 1957, glass container production was 10,767,000 gross, or 1.8 per cent over the December, 1958, figure. At the end of 1958, glass container manufacturers have produced a preliminary total of 145,075,000 gross. This is 1.7 per cent below the 147,512,000 gross produced during the same period in 1957.

Shipments of glass containers during December, 1958, came to 10,784,000 gross, a decrease of 0.6 per cent from November, 1958, which totaled 10,851,000 gross. Shipments during December, 1957, amounted to 9,512,000 gross, or 1.2 per cent under December, 1958.

At the end of 1958, shipments have reached a preliminary total of 143,446,000 gross, which is 0.3 per cent over the 142,971,000 gross shipped during the 12 months of 1957.

Stocks on hand at the end of December, 1958, came to 18,675,000 gross. This is 1.5 per cent under the 18,968,000 gross on hand at the end of November, 1958, and 4.7 per cent higher than the 17,834,000 gross on hand at the end of December, 1957.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	December, 1958
Food	977,000
Medicinal and Health Supplies	1,310,000
Chemical, Household and Industrial	700,000
Toiletries and Cosmetics	719,000
Beverage, Returnable	707,000
Beverage, Non-returnable	97,000
Beer, Returnable	166,000
Beer, Non-returnable	701,000
Liquor	627,000
Wine	403,000
Sub-total (Narrow)	6,407,000

Wide Mouth Containers

Food	*3,183,000
Medicinal and Health Supplies	373,000
Chemical, Household and Industrial	128,000
Toiletries and Cosmetics	228,000
Packers' Tumblers	35,000
Dairy Products	206,000
Sub-total (Wide)	*4,153,000
Total Domestic	10,560,000
Export Shipments	224,000
TOTAL SHIPMENTS	*10,784,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production Dec., 1958	Stocks Dec., 1958
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	3,871,000	6,787,000
	Wide Mouth	*3,865,000	*6,077,000
Beverage, Returnable		592,000	1,692,000
Beverage, Non-returnable		90,000	219,000
Beer, Returnable		169,000	450,000
Beer, Non-returnable		635,000	869,000
Liquor		693,000	1,440,000
Wine		432,000	789,000
Packers' Tumblers		16,000	103,000
Dairy Products		210,000	249,000
TOTAL		*10,573,000	*18,675,000

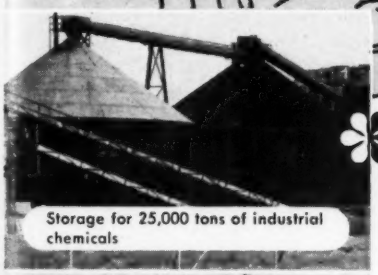
*This figure includes Fruit Jars and Jelly Glasses.

50 YEARS FOR OAKITE

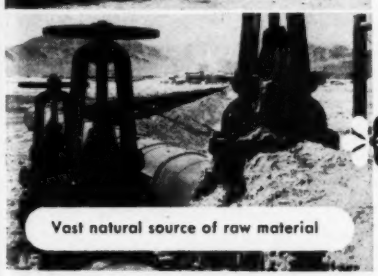
Oakite Products, Inc., New York, is celebrating its 50th anniversary in the field of industrial cleaning, including the cleaning of glass molds. The company was first formed in 1909 under the name of Oakley Chemical Company. At that time the firm introduced its own ideas to industry in compounded cleaning formulas for removing soil by emulsification. Under the leadership of founder David C. Ball, and his associates, Daniel C. Smith and George W. Oakley, the company made a niche for itself in this important field of industrial cleaning. The name was changed to Oakite Products, Inc. in 1926, and the company now serves some 36,000 industrial concerns in the United States and Canada.

West End "fills the order"...

TO PLANT 9/11 2:35 P M
HAZCO URGENTLY NEEDS EXTRA
HOPPER CAR SODA ASH FROM TANK
6 SHIPPED TODAY. ADVISE. END
TO OFFICE
CAN DO. WILL PULL CAR FROM
STORAGE SPUR AND SHIP TODAY.
CAR NO. NAHX 31078.


Storage for 25,000 tons of industrial chemicals

Immediate shipment in leased hopper cars


Vast natural source of raw material

Meeting service requirements to the letter and producing superior soda ash of consistently accurate particle size and chemical analysis are the essentials to which the West End organization is uniquely geared. A system of rapid communications linking our sales office in Oakland with our production, technical and shipping departments at the desert plant site permits each department head to have a complete understanding of the customer's individual requirements and to make firm commitments or provide the desired information promptly.

WEST END SODA ASH

WEST END CHEMICAL COMPANY

EXECUTIVE OFFICES, 1956 WEBSTER, OAKLAND 12, CALIF. • PLANT, WESTEND, CALIF.

DIVISION OF Stauffer CHEMICAL COMPANY

New Equipment and Supplies

RIBBON BURNERS

Bethlehem Apparatus Co., Inc., Hellertown, Penna., is making a line of gas-oxygen ribbon burners for use in flaring, glazing, cracking, annealing, and sealing hard glass and quartz in glass shops, laboratories, and plants where glass products are manufactured and fabricated. Air can be added for soft-glass operations.

GAS-AIR BURNERS

Selas Corporation of America, Dresher, Penna., has an improved and enlarged line of Multiport P-R gas-air burners which combine positive flame geometry with maximum heat release and low turndown. Applications include glass fire polishing and forming, and heat treating materials.

GLASSWARE COATING

The glass and closure research department of Armstrong Cork Company has developed a new type of coating, called "Armacote," which the company says is inert, invisible and harmless. The coating gives "better lasting protection to glassware from the annealing lehr through the packing lines to the consumer."

LIGHT-PRODUCING PANELS

Westinghouse Electric Corporation, Pittsburgh, Penna., has announced a line of light-producing panels ranging from 2" x 2" to 24" x 24" in standard colors of green, blue or yellow.

The Rayescent lamps consist of a sheet of glass coated with a phosphor layer and an electrically conductive coating. When voltage is applied, light produced by the phosphor is emitted from the transparent front surface.

ELECTRICAL INSULATOR

National Beryllia Corp., 4501 Dell Ave., North Bergen, N.J., has made available "Berlox" beryllium oxide which, the company states, is available for use in applications at temperatures up to 4600°F. It is said to be an excellent electrical insulator with thermal conductivity equal to that of brass and may be used for pyrometer sleeves in the most corrosive high-temperature applications.

BATCHING SCALES

Thayer Scale Corp., Pembroke, Mass., have redesigned their batching systems with the addition of electro-permanent magnetic vibratory feeders to insure a continuous, regulated flow of material to the weigh hoppers. The HI-VI magnetic vibratory feeders are a product of Eriez Manufacturing Company, Erie, Penna.

EXPLOSION-PROOF PRESSURE CONTROL

United Electric Controls Co., Watertown, Mass., has announced a new explosion-proof control for air, gas or liquid pressures. It is especially designed for use in hazardous locations where explosive vapors or gases are present. Calibrated pressure settings are made by rotating a single turn adjustment knob and pointer against a fixed calibrated dial.

MULTI-SWITCH INDICATOR

Barber-Colman Company, Rockford, Ill., has a new multi-switch indicator for checking temperatures at many points. Switching details allow the instrument to be used for as many as 108 stations; additional stations may be added through the use of another switch housing cabinet.

TEST FURNACE

Harrop Electric Furnace division, Harrop Ceramic Service Co., Columbus 19, Ohio, has a newly designed test furnace for the ceramic industry. This model, GF-11, is designed for evaluating the firing properties of ceramic materials when gas-fired under oxidizing or reducing conditions. The burner system is regulated by a single lever control and is so arranged that the gas-air ratio is constant during the firing cycle.

POLYURETHANE WHEELS

Disogrin Industries, Inc., 510 South Fulton Ave., Mount Vernon, N. Y., states that the Hazel-Atlas Glass division of Continental Can, Washington, Penna., has been testing new wheels manufactured by Disogrin. Made of a polyurethane elastomer, these wheels have met with success at Hazel-Atlas; at the end of a year-long test, the wheels were inspected. No evidence of "chunking" out was found, no floor breakage, no noise and no loss in load-carrying capacity.

CATALOGUES RECEIVED

Clark Equipment, Battle Creek, Mich., has issued a brochure giving complete specifications and a full description of operating characteristics and advantages of four high-lift, battery-powered hand trucks. Charts indicate lifting heights and lift speeds of all models, and drawings show turning radius and dimensions.

The Young Machinery Co., Inc., Muncy, Penna., has a 12-page bulletin which gives complete dimensions for mixers up to 500 cubic feet working capacity. The booklet illustrates various arrangements of ends, supports, agitators, shafts, glands, covers, inlets and discharges, and gates and drives. Write for Bulletin F-1058-56.

Toledo Scale Corporation, Toledo 12, Ohio, has issued a comprehensive 8-page brochure on automatic batching systems which describes the latest product developments.

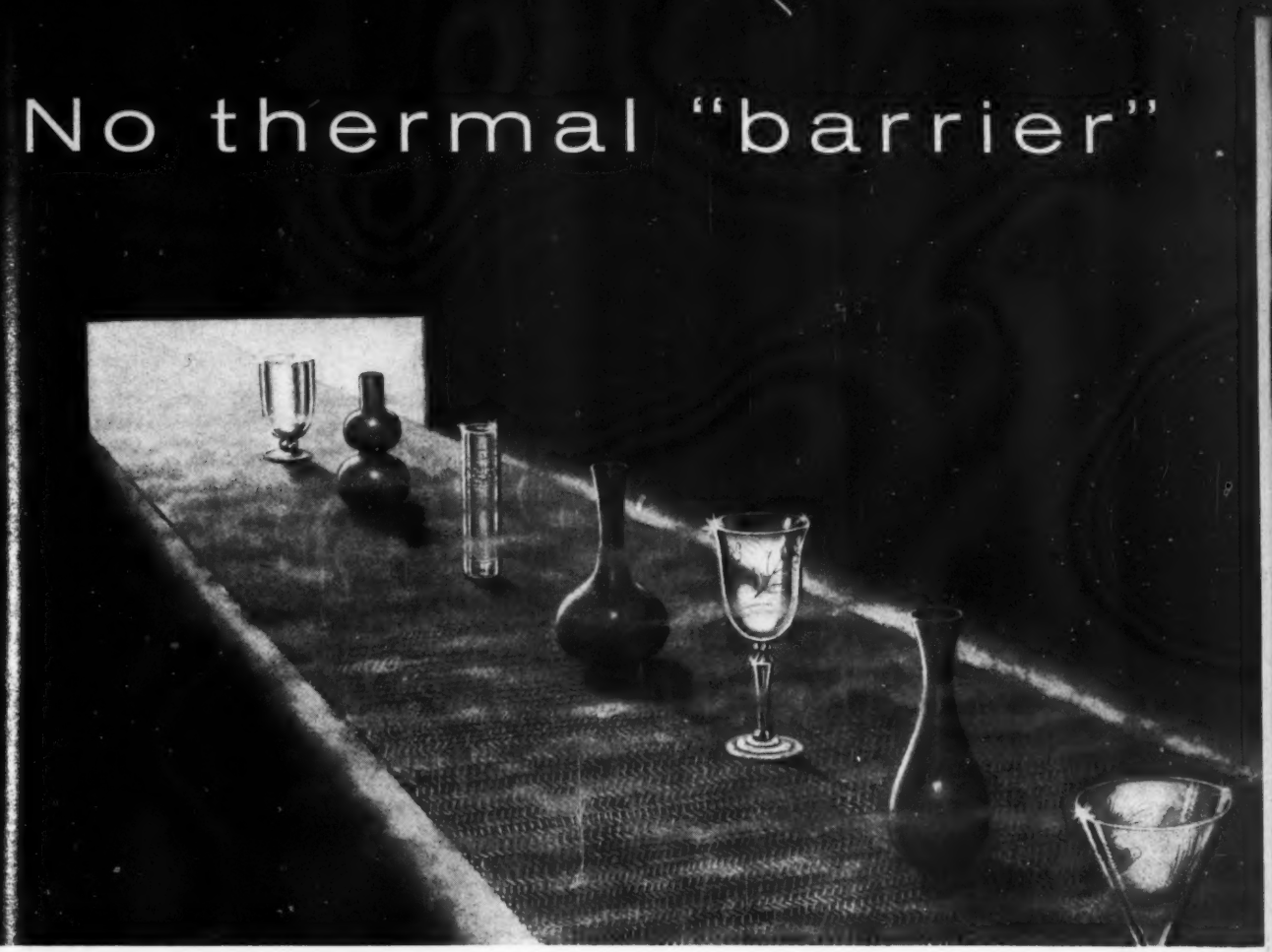
Emphasis is given both to remote setting of formulas and remote recording of digital data.

Towmotor Corporation, Cleveland, Ohio, has released a 12-page booklet on the Towmostatic Drive, a new method of power application for fork lift trucks.

Fuller Co., Catasauqua, Penna., has a four-page technical reprint entitled, "What Every Plant Engineer Should Know About Air Compressors." Included are a list of questions to help solve operational problems, a list of frequent hazards and safety precautions, and a glossary of technical terms. There is also a bibliography on reference books concerning air compressors.

Corning Glass Works has issued a supplement to its Pyrex brand laboratory glassware catalog. The booklet covers, in addition to Pyrex, Vycor brand 96 per cent silica laboratory ware and over 700 custom-made items. There are 36 pages.

No thermal "barrier"



when you use WISSCO LEHR BELTS

EVEN HEATING—Because of their open mesh construction, Wissco Lehr Belts do not become a thermal "barrier" in glassware or ceramics heat-treating operations. The specified heat flows through the belt, evenly and consistently, to do its work on the material being treated.

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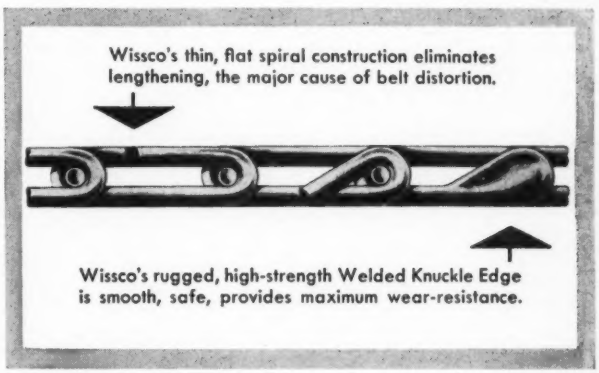
TEMPERATURES UP TO 2100° F.—Standard Belts, in both Balanced and Conventional Spiral weaves, are available for use where operating temperatures do not exceed 1100° F. Belts fabricated in special-analysis alloys are available for temperatures as high as 2100° F.

Contact the CF&I sales office nearest you for information, literature or engineering assistance on your woven wire belt problems.


Wissco's thin, flat spiral construction eliminates lengthening, the major cause of belt distortion.
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CF&I **WISSCO BELTS**
PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
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All-Electric Melting of Glass

(*Continued from page* 70)

more glass after the fuel has reached its limit. Power consumption for a booster is 480 KWH or less per short ton of extra glass produced. At a power cost of $0.008 per KWH, the cost of heat for the extra glass produced by boosting is only $3.84 per short ton. This cost is usually quite acceptable in view of the extra profit to be made from the sale of glass which otherwise could not have been manufactured.

c. One factor which partially compensates for the adverse fuel economics of large all-electric furnaces versus large fuel-fired furnaces is the decreased cost of repair in an all-electric furnace. The only parts to be replaced at the end of a campaign are the sidewall blocks and the throat cover blocks. The floor and crown remain in good condition for many campaigns. There are no checkers to be replaced. An all-electric furnace of 40 tons daily output was repaired in 10 days, glass to glass. The repair cost for each ton of glass produced in the previous campaign was only 25 cents.

d. When low-cost electricity is available, the discouraging picture presented in paragraph *4a* is changed to an optimistic one. When the cost of heat is less than about $3.50 to $4.00 per ton of glass produced, the cost of heat is no longer a deciding factor. This corresponds to a power cost of $0.005 per KWH. Then all-electric melting can be chosen for its other advantages.

On the other hand, if fuel is high-priced, or uncertain in supply, the price that can be paid for electricity is much higher. The prediction of petroleum economists is that in about 20 years the fossil fuels will be too valuable for their chemical content to be used for the simple generation of heat. When this comes to pass, this paragraph will have more meaning than it does today.

e. If there is a limitation as to available space, an all-electric furnace has an advantage in that it has only a melting basin and a channel which distributes the glass to the feeders. It does not have regenerators, ports, flues, reversal valve, chimney, or working end, and therefore the required building space is much smaller.

f. One of the advantages of an all-electric furnace is the reduced capital outlay for a furnace of a given size. The following cost figures are given in sufficient detail to permit adjustment by the reader for local conditions.

The table of costs (refer to page 70) does not show an item for foundation and piers, since this will vary. For such calculations, the total weight to be allowed for is given.

There is no figure for the incoming power supply, since a special estimate will have to be made in each case according to such factors as the distance from the substation and the supply voltage.

The figure for the electrical equipment will vary as shown, according to whether the furnace control is made fully automatic, whether instruments are indicating or recording, etc.

Conclusion.

The technology of electric melting has already been brought to the point where this method is known and reliable, with efficiencies not too far away from the theoretical. Further improvements will be made, of course, but the area of possible improvement has now been diminished greatly as a result of work done in the last few years. In other words, the method of all-electric melting is reaching maturity technologically.

The foregoing paper has attempted to clarify the proper place of all-electric melting in relation to the fuel economies of today, with the suggestion that all-electric melting will become more and more important as the world shifts from fossil fuels to other sources of energy.

Investigation of Materials for Glass Container Molds

(*Continued from page* 81)

The structure of this mold at its working surface and at its outer surface was similar to that of the blank mold already discussed. The structure of graphite on the working surface was rather fine, whereas the core and the outside showed somewhat coarser flakes, as shown in Figures 5 and 6. Small amounts of pearlite were imbedded in the predominantly ferritic matrix.

The working surface of the bottom plate showed fine eutectic graphite formation which became fine flake toward the outer surface of the mold. The matrix was ferritic, including a small portion of pearlite which increased toward the outer surface of the mold, as shown in Figures 7 and 8.

The Brinell hardness of the blow mold ranged from 120 to 135 and that of the bottom plate varied from 130 at the working surface, to 150 at the outer surface.

Mold Set No. 2

In view of the fact that the two molds of this set showed no essential differences in their structure, only one of them was chemically analyzed. The composition was as follows:

Composition Per Cent by Weight

C total	C combined	Si	Mn	P	S	Ni	Cr	Mo	Al
3.53	0.34	2.33	0.72	0.21	0.07	0.29	traces	traces	traces

The graphite formation at the working surface of these molds, shown in Figure 9, was considered to be very favorable. It was evident from the structure of the finely precipitated graphite that this had been a preshaped mold. The matrix contained fine pearlite in addition to ferrite, which in some places was dendritic.

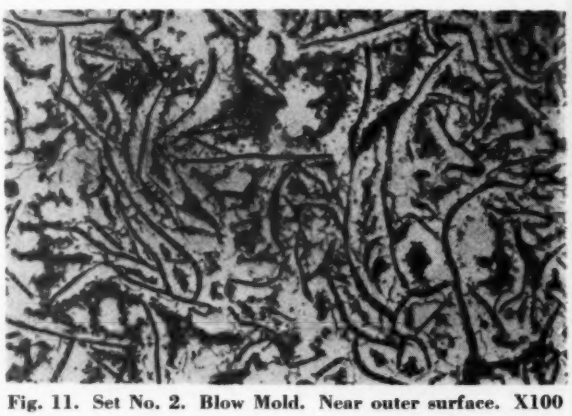

Fig. 11. Set No. 2. Blow Mold. Near outer surface. X100

(*Continued on page* 98)

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(*Continued from page* 96)

In a zone about ½ to ¾ inch from the working surface in the direction of the outer surface, the fine eutectic graphite abruptly became coarsened into flake, as shown in Figure 10. The structure became particularly coarse at the outer surface, as shown in Figure 11.

In spite of its comparatively small cross section, the bottom plate belonging to this mold-set showed a rather nonuniform structure. The structure of the working surface, shown in Figure 12, consists of fine eutectic graphite with occasional clustered graphite and ferrite. The outer surface showed the customary coarse flake graphite formation.

The differences in the structure are probably due to uniform nucleation in the melt.

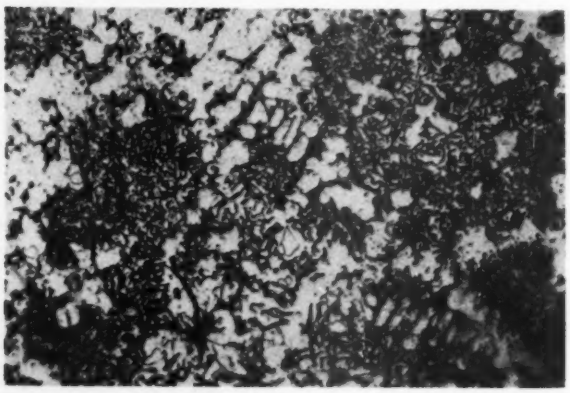

Fig. 12. Set No. 2. Working surface, bottom plate. X100

The Brinnell hardness of the two molds of Set No. 2, as well as the bottom plate, varied from 180 to 190 at the working surface to 100 to 125 toward the outer surface.

Discussion

The molds examined showed a very satisfactory operational behavior. While the fine structure of the working surface of Set No. 2 justifies such a behavior, the structure of the molds of Set No. 1 may hardly be termed as favorable, in view of previous experience on European molds, as reported in the first article of this series.

In this first article, we reported that cracks started from oxidation seams along graphite flakes especially where these met into clusters. In the present case, the graphite flakes of Mold Set No. 1 were considerably smaller and showed little tendency toward clustering. Such a structure is evidently not as detrimental to mold life. We must further assume that Mold Set No. 1 was operated at lower temperatures or under otherwise favorable conditions.

The Glass Industry—1958

(*Continued from page* 71)

tronics with the successful design of a casing for transistors, the tiny devices that are now doing the work of radio tubes in many electronic applications.

The all-glass transistor case has won customer acceptance in a new field that may reach an annual production rate of many million units within the next few years. Corning has also started production of very pure fused silica crucibles used for growing silicon crystals that are the heart of the transistor.

Another electronic product that moved from laboratory to factory in 1957 was the metallized glass circuit board. Made of Fotoceram, strongest of Corning's photosensitive glasses, the new printed circuit board can operate under extreme conditions of temperature and humidity. These advantages, manufacturers have found, make them ideal for missile and other electronic applications. Quantity production has now begun.

Cathode Ray Tubes

Cathode ray tubes capable of withstanding extremely high bakeout temperatures were shown in 1958. Made of either low expansion Pyrex brand glass or Vycor brand glass, the tubes can withstand the temperatures (600°C. to 1000°C.) encountered in baking transparent phosphors to a face plate.

Transparent phosphor applications in cathode ray tubes have lately been recognized for use in equipment that can be installed in high light-intensity places, like a radar set in a CAA control tower. Other applications for tubes with transparent phosphor coatings include flat tubes inside jet plane canopies. The component feeds the pilot visual information on altitude, position, and speed while enabling him to see continually through the tube to orient himself.

New Type Television Tubes

Through the development of a new method of glass lamination, Corning Glass Works has introduced a shatterproof, dust-free contoured twin panel television tube. The tube consists of a second contoured glass-face panel laminated permanently to the original bulb, eliminating the need for the present front safety plate. The twin panel tube, after lamination, is as shatterproof as a modern automobile windshield, and the two inside glass surfaces are dust-free for life.

Two new laminating materials were developed, one by Rohm & Hass Company, the other by Dow Chemical Company, to make the new process possible. Each of the two substances has the same refractive index as the tube glass and panel glass. The process consists of simply casting a liquid plastic between the surfaces to be laminated. No pressure is required, and only moderate heat. The new laminating materials do not require the use of special mountings or gaskets.

Pittsburgh Plate Glass Company has also developed a new type of TV tube with built-in safety, which makes it possible to eliminate the present separate front window now standard on all TV sets.

This particular laminated safety tube consists of two PPG products, gray Teleglas and Selectron polyester resins, and provides a picture brightness improvement of from eight to nine per cent, improving the contrast between light and dark parts of the picture. It furthermore is said to eliminate objectionable reflections from both surfaces of the present window and lessens glare.

Instead of the present outside safety glass window, the new tube will have a new lightweight one curved to fit the tube face and acid-etched to provide the satin finish,

(*Continued on page* 100)

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(*Continued from page* 98)
laminated directly to the face of the picture tube by means of a layer of Selectron polyester resin.

Several major manufacturers are studying the feasibility of producing the new unit tube and are engineering for pilot plant production; the tube may reach the public in TV receivers coming on the market in mid-1959.

VII—Raw Materials

Consumption of lepidolite and petalite by the glass industry during 1958 was substantially reduced, probably resulting from lower television glass output, drastic efforts to decrease inventories, and the significant advent of Canadian and United States glass-grade spodumene shipments to the industry. The total lepidolite and petalite imports this year are estimated to be approximately equal, each totalling 13,000 net tons.

A rather significant volume of research directed toward establishing a large tonnage spodumene use in glass has been reported, and these results indicate encouraging possibilities. The use of lithium carbonate in small amounts as a substitute for other alkali ingredients appears to offer improvements in the fining time of various glasses.

During 1959 it is expected that the television glass consumption of imported lithium minerals will fall to less than half of 1958 as the conversion to domestic spodumene proceeds. Borosilicate glass requirements for lepidolite will probably continue to increase. The volume of petalite being received in the refractory, specialty, whiteware, and porcelain enamel markets is increasing at a fairly rapid rate and will likely continue.

Prospects are good for the use of lithium oxide in glasses. A ceramic grade spodumene has proven in pilot operation to exceed the forecast in its analysis of 7.4 per cent lithium oxide. It is esentially a 30-100 mesh product, free-flowing only slightly off white, and devoid of all discolored grains. Its iron content is in the order of 0.60 per cent, near wholly as ferrous, combined in the spodumene crystal. It is not expected that this "high iron" will be necessarily limiting in its glass application owing to the minor percentage use of spodumene in individual batches, rarely exceeding 2.5 per cent.

Cerium in flint glass has market potential in the container field due to its ultraviolet absorbing properties. Containers made of such ultraviolet-absorbing glass should be considered for use in packaging materials which tend to be spoiled by light. Such materials are now often packed in amber glass bottles. The list of products which are now using amber glass is long and varied. Vegetable oil products, beer, bleaching solutions, and pharmaceuticals are a few of these items.

The fact that cerium glass can be colorless in visible light and afford the advantages of protection from ultraviolet light is its most important feature. Pharmaceutical pills and capsules, for instance, are produced in many bright colors. Psychologically they are more attractive to purchase and supposedly to take, but are marketed in most cases in a drab brown bottle. A major brewery packages its beer in clear flint bottles which show the purity of their product, but it does not receive the advantage of ultraviolet protection.

The color of the cerium glass will vary from colorless to straw or brown if selenium is present. Manganese decolorizing shows promise when used with rare earths. With the use of cerium, it may be possible to use higher than normal iron-bearing sands in the glass batch.

Nearly colorless glasses showing ultraviolet absorption may also be made with cerium oxide in combination with cobalt or vanadium oxides. Vanadium tends to impart a green yellow color to the glass, but cobalt and cerium oxides give glasses which are nearly colorless or have a very light blue color. Suitable ultraviolet-absorbing glasses contain 1.9-6.5 per cent CeO_2 with 0.5-2 per cent V_2O_5, and 2-3 per cent CeO_2 with 0.01-0.02 per cent Co_2O_3. With cerium contents as low as a few tenths of a per cent, the ultraviolet absorption may still be enough to make useful containers.

The usual form of adding cerium to the glass batch is as cerium hydrate. However, for low-cost application, the cerium should be added in its cheapest form.

Rare earth sodium sulfate presents the most economical source of 21 per cent CeO_2 for use as the glass additive. The use of rare earth sodium sulfate as the source of cerium has been verified by actual batch tests.

The composition of rare earth sodium sulfate is $RE_2(SO_4)_3.Na_2SO_4.2H_2O$. It is a light pink crystalline powder, sparingly soluble in water and acids. In normal manufacture it is dried, and some of the water of hydration (combined water) is removed. The pink color is due to the rare earth neodymium.

Rare earth sodium sulfate is a primary product obtained from the chemical processing of cerium ores such as monazite. Therefore, it is the cheapest source of cerium where the other rare earths do not interfere in its use. For ultraviolet absorbing glass use, these other rare earths do not interfere and may actually serve a useful purpose as physical decolorizers.

VIII—Future Trends and Developments

Glass containers, as a result of developments now under way, are definitely bidding not merely to hold their share of the expanding packaging market but to increase it. Commercially we are attaining about 1 per cent of the highest measured strength of glass. If this can be increased to 10 per cent of the highest measured values, a new and different world for the packager will be attained.

Furthermore, electronic devices are being perfected that will provide improved automatic inspection machinery to assure consistent quality. Automation programs now under way are strongly counted on to keep glass bottles and jars fully in line with their principal competitors.

Lighter, stronger glass containers will be available. Within the foreseeable future packagers will be able to ship three bottles that together will tip the scale at a weight about the same as one of today's "light-weight" containers. The new containers will be just as strong as today's bottles and jars, and perhaps with the results of new processing and coating techniques they may be practically unbreakable.

Glass packaging is a major candidate for the growing number of convenience products, including the "heat and serve" types of food; new types of drugs and phar-

(*Continued on page* 102)

HARBISON-WALKER

zircon brick

zirconium silicate refractory

with properties of distinction reflected in serviceability

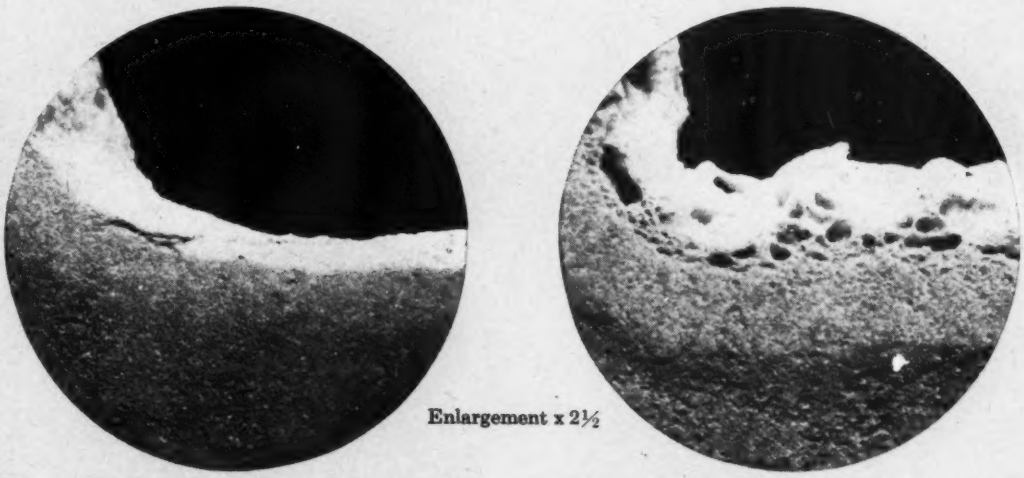
H-W Zircon brick, made from the mineral of high purity, in many rectangular sizes and shapes, are formed by impact pressing. This method of manufacture contributes to the exceedingly desirable properties of density, homogeneous texture, both compressive and transverse strength and precision in workmanship. Other physical properties of H-W Zircon possessed to the maximum degree are unusually high strength and constancy of volume at temperatures ranging up to and exceeding 2900°F. Their excellent resistance to thermal spalling and to severe fluxing conditions are properties of paramount importance for many applications.

The minute and homogeneous pore structure of this refractory accounts for its low permeability and high resistance to impregnation by molten glass. Chemical composition and superior physical properties of H-W Zircon are such that, in contact with molten glass, foaming is not induced in the manner characteristic of various refractories.

All of these properties commend H-W Zircon for paving glass tank bottoms and for use in various vulnerable parts of the superstructure.

Write for further information and technical service.

These photographs show sections of two commercial brands of zircon brick which were tested in contact with molten glass batch. Pockets 2½" in diameter and ¾" deep, in each brick, were filled with equal amounts of the same plate glass batch and heated to 2730°F. for five hours.



Enlargement x 2½

H-W Zircon brick, tested with plate glass batch, showing negligible reaction, freedom from foaming and smooth uniform texture of the brick.

Another commercial brand of zircon brick, tested with plate glass batch, illustrating foaming and the degree of penetration.

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(*Continued from page* 100)

maceuticals, and a long list of household and do-it-yourself items. Already the recent gains in these fields have pointed up a successful packaging trend. Glass will offer greater inherent beauty and probably a broader range of inexpensive colors. Closures will be even simpler, surer, and more convenient.

The recent decline in demand for flat glass has coincided with an enlargement of domestic capacity and an increase in the amount of window and plate glass imported from abroad. A high level of domestic demand in 1955 influenced the industry to expand its capacity in anticipation of future requirements. However, imports have increased significantly, encouraged by high domestic prices and tariff reductions, and now account for nearly 20 per cent of domestic consumption as compared with less than 9 per cent in 1954. Moreover, recent agreements provide for a further tariff reduction of 5 per cent, and this may be followed by still another reduction. Imported glass, which has been confined to the coastal, areas thus far, comes principally from Belgium and France.

Despite the current leveling of demand for flat glass, growth in the postwar period has been substantial. The average new automobile contains 50 per cent more glass area than formerly. Significant from the standpoint of sales and profits is the fact that the new wind-shield incorporates elaborate bends and hence is substantially more expensive than ordinary plate glass.

Studies of architectural trends indicate that the average home constructed today uses 36 per cent more glass in relation to floor area than it did 10 years ago. The rate of increase in industrial and commercial usage over a similar period, though somewhat less, also has been substantial.

Special types of colored and opaque plate glass are experiencing increased usage as a structural facing material for store fronts, apartment buildings and office buildings.

Continuing growth in important markets should result in above-average demand for existing glass products over the long-term. Expansion in population and consumer incomes, combined with modern design trends, points to further enlargement in the markets for flat glass and fiber glass insulation products. In the container field, it is anticipated that product development and improvement will continue to offset the increasing competition from paper, plastic, and metal containers. The technological progress made in aviation, atomic energy, and many other industries has resulted in a demand for materials possessing unusual characteristics. In view of the many favorable properties of glass, continued research efforts are likely to produce further important applications for glass in these and other areas.

Some Aspects of Heat Recovery in Glass Furnaces

(*Continued from page* 79)

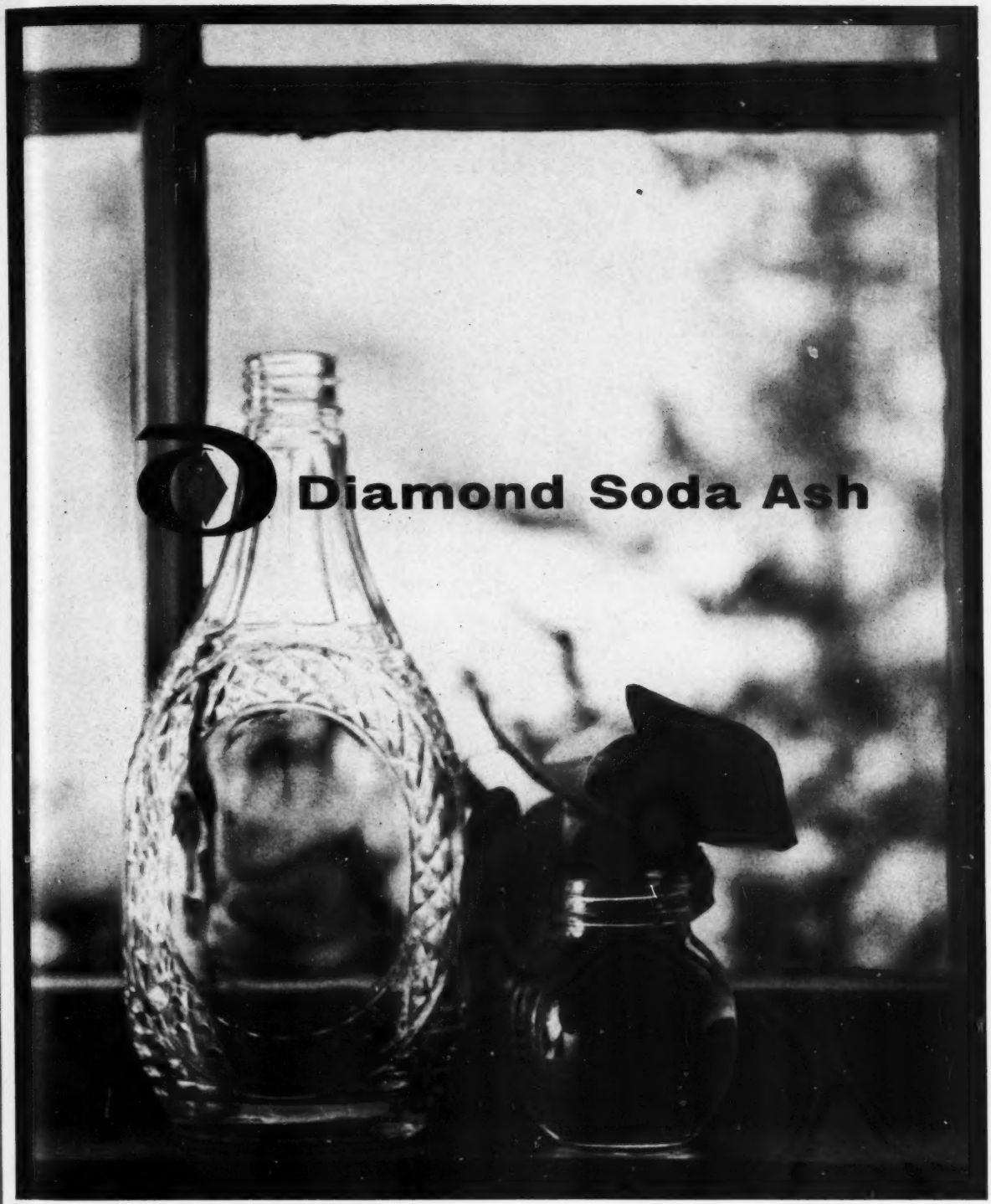
A relatively small amount of heat is also transferred from the waste gas by convection. In applications where the temperatures are low, convective heat transfer is increased by installing swirlers in the flue gas passage.

The inner shell, being relatively thin, readily conducts the heat from the waste gas passage to the air annulus. Heat is also transferred from the inner tube by radiation to the outer shell which acts as an additional surface for heating the air.

The recuperator is suspended vertically from supports located near the upper end, thus reducing the stresses on the lower portion. Longitudinal expansion is accommodated by an air-cooled slip joint at the flue connection while the differential expansion between the inner and outer tubes is taken up by a bellow-type expansion joint in the outer shell. Expansion joints are also used at the air connections to eliminate any external stresses on the recuperator.

Alloy steels, containing up to 25 per cent Cr and 20 per cent Ni are used for the inner tube, while lower grade

(*Continued on page* 104)



For the look of beauty, the assurance of quality in glass containers and flat glass products, start with the soda ash of proved uniformity; assure uniform results batch after batch.

DIAMOND ALKALI COMPANY, Union Commerce Building, Cleveland 14, Ohio

Diamond Chemicals

(*Continued from page* 102)

alloys and, in some areas, mild steel are used for the outer tube and header boxes.

The entire system is insulated, with the exception of the cold air piping and the lower portion of the recuperator where the waste gases enter. The uninsulated section of the recuperator provides protection against overheating when the air supply is interrupted or reduced. For normal operation the unlagged section is kept cool by the flow of air sweeping through the annulus, and external heat losses are small. When the air is interrupted or reduced to a small flow, the temperature of the outer, unlagged surface will rise and can dissipate heat at a rate sufficienty high to prevent a dangerous rise in metal temperature in the high-temperature zone.

Conditions For Application

As mentioned earlier, the recuperator can be designed for parallel or counter flow. There is a third arrangement of two stages which can be used, as illustrated in Fig. 7, the primary stage being the top section with counter flow and the secondary stage, the lower section with parallel flow. The choice of arrangement depends upon the volume and temperature of the flue gases and air preheat requirements.

Generally speaking, to avoid excessive metal temperatures at the waste gas entrance, parallel flow is used where flue gas temperatures are above 2000°F, and

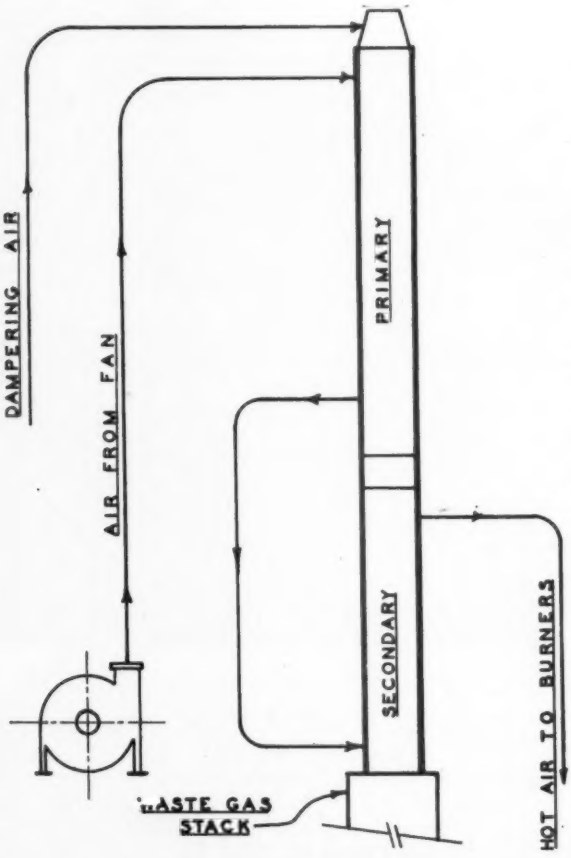


Fig. 7. Schematic arrangement of two-stage recuperator.

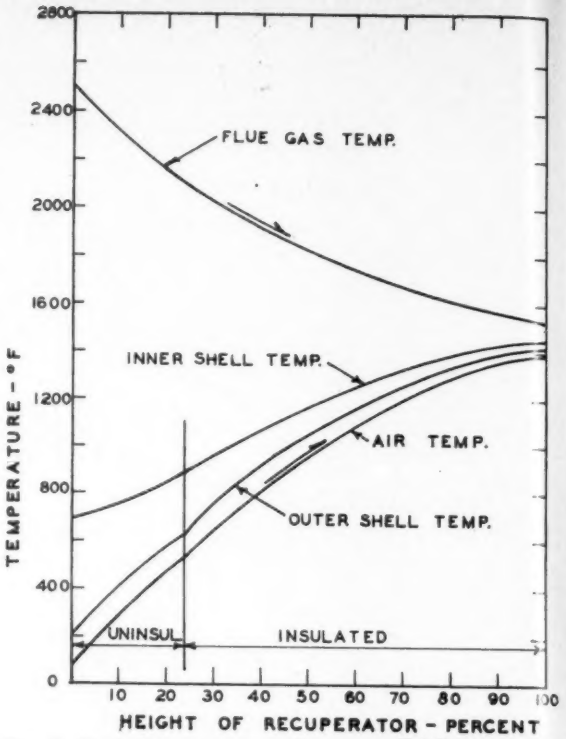


Fig. 8. Typical temperatures for a parallel-flow recuperator.

counterflow, with its inherent high mean temperature differences, is used in the lower temperature range. Figures 8 and 9 show typical temperatures for the heating surfaces, the air and flue gas of parallel and counterflow recuperators.

The two-stage system is applied where the conditions are such that the required air preheat cannot be achieved by a parallel flow recuperator and flue gas temperatures are too high for the direct application of a counter flow type.

The recuperator can be applied to furnaces with flue gas temperatures well above the allowable safe working temperature of the metal. This is possible because the flue gases do not impinge against any section of the heating surface, and radiation from the inlet flue is distributed over a large area by radiation interchange within the cylinder. Single recuperators can handle the waste gas from furnaces utilizing up to 20 mm BTU's per hour of fuel with maximum operating temperatures of 2900°F.

Two or more recuperators can be combined for furnaces of a larger size. The combustion air can be preheated to 1400°F without approaching the maximum safe working temperatures for the materials in the recuperator.

The changes in fuel requirements, which occur with an increase in production and with furnace age, do not have a large effect on the air pre-heat temperature. For example, a 50 per cent increase in fuel with a recuperator designed to give 1400°F air pre-heat, will cause a drop in air temperature of approximately 75° F. This is based on the average changes in operating conditions that occur during a campaign and covers the range of most glass-melting furnaces. (*Continued on page* 106)

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(*Continued from page* 104)

Almost any type of fuel can be used in conjunction with the recuperator. With gaseous fuels, the hot air is usually introduced through the burners. For fuel oil, the secondary air, being heated to a high temperature, is introduced through furnace ports near or adjacent to the oil burners. Air is also drawn off the recuperator at a low temperature level by means of a bleed belt and used at the burners for atomization.

Features and Advantages

The design features and advantages offered by this type of recuperator can be summarized as follows:

1. The recuperative continuous firing method overcomes many of the design and operational limitations imposed by regenerative systems.
2. The unit can accept flue gases directly from furnaces operating at temperatures up to 2900°F.
3. The unobstructed flue gas passage offers a minimum resistance to flow and reduces the possibility of carryover buildup.
4. The danger of localized overheating is eliminated due to no direct impingement of waste gases and the equalization of temperature by radiation interchange within the cylinder.
5. Optimum overall heat transfer rates are obtained due to the thin metal wall between the air and flue gases, forced convection by high air velocities and high radiation from low-velocity flue gases.
6. The design fully accommodates the internal differences in expansion, thus avoiding failure due to secondary stresses at elevated temperatures.
7. The built in safeguard against overheating, when the air is interrupted or reduced to a small flow, eliminates the need for elaborate safety devices.
8. The integral construction provides a sealed system for accurate control of the combustion air.
9. The unit, being mounted in a vertical position, acts as the furnace stack, and a separate stack is not required.
10. The foundations and building space requirements are minimized by the compact design.

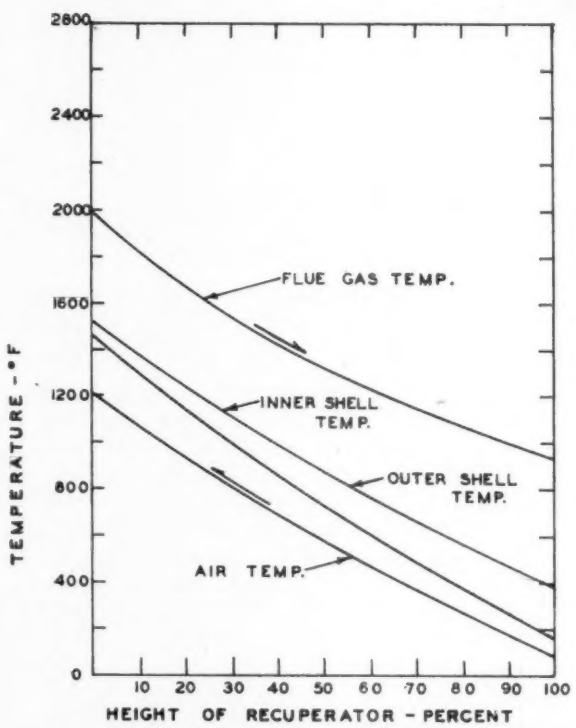


Fig. 9. Typical temperatures for a counter-flow recuperator.

Applications

Mr. Escher, the inventor of this device, has many recuperators installed in Europe, Australia, and other countries throughout the world. Installations have been made on glass-melting furnaces, metal processing, and other furnaces where waste gas temperatures make fuel saving through combustion air pre-heat desirable. Some of these installations have been operating since 1950 without any signs of deterioration.

In the United States, recuperators of this design have been installed on small direct-fired glass melting furnaces and the savings predicted have been obtained with trouble-free performance.

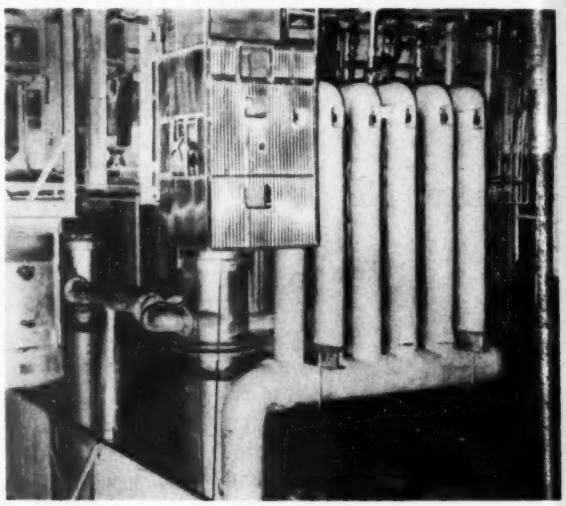


Fig. 10. Recuperator on a textile furnace.

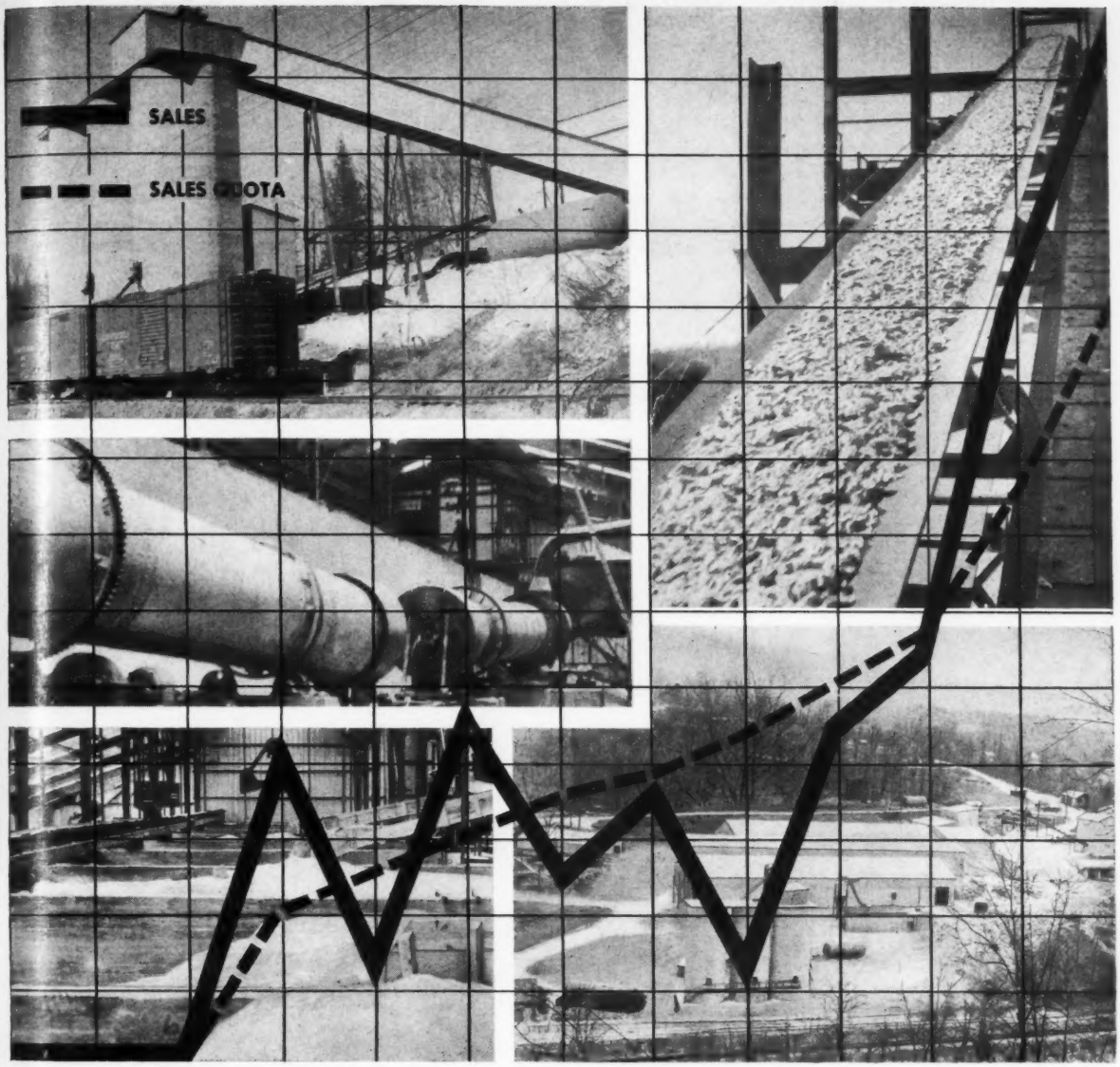
Figure 10 shows a particular installation made in August, 1956. This direct-melt fiber glass furnace is operated at a rate of 2½ to 3 tons of glass per day, with melting temperatures ranging between 2750° and 2900°F. Under normal operating conditions, the combustion air is heated to 1350°F and this gives a reduction in fuel input of 37.5 per cent. The furnace performance was also improved with the use of the hot combustion air, making increased temperature, and consequently increased production, easier to attain.

In the spring of this year, the furnace was shut down for rebuilding and the recuperators were thoroughly inspected. No repairs were required at that time, and they were put back into service for a second campaign.

REFERENCES

Fig. 2—Relationship Between Heat Available and Air Preheat. W. Trinks—INDUSTRIAL FURNACES—Volume I, 4th Edition, P. 221 Fig. 155, Illustration of method of computing savings of fuel due to pre-heating of air.

Fig. 7—Heat Transfer by Gaseous Radiation. W. Trinks—INDUSTRIAL FURNACES—Volume I, 4th Edition, Fig. 36, P. 32.



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The Making of a Glass Man

(*Continued from page 76*)

research or director of development programs ever had any more courageous backing in his ideas than I have had in the development of Fiberglas.

Arthur D. Little, Inc., of Cambridge, Massachusetts, were hired as scientific consultants from the beginning of Fiberglas activity at Evansville, Indiana, and are still consultants for our Corporation. Earl P. Stevenson, now Chairman of the Board of Arthur D. Little, Inc., and his people, have contributed majorly to the development of our products and processes. For instance, through Mr. Stevenson we were put in contact with Professor Edgerton, of Massachusetts Institute of Technology, and we were the very first to use his high-speed, photographic technique in studying a commercial process.

This gave us the opportunity of seeing what happens in our fiber-forming process; I feel we could not have made the progress we did, had we not had those pictures. Through Mr. Stevenson, we were put in touch with Dr. Kleinschmidt who made the mathematical analyses which resulted in our building the steam blower, up to recently, the basis of our insulating wool business.

Mr. Stevenson suggested that I contact Dr. Goddard who was then experimenting with rockets, which I did. Dr. Goddard visited me and the suggestions of this wonderful scientist (who was the father of the modern rocket) helped in the development of what we call the aerocor process and the improvement of the steam blowers.

About 1936, after we had established manufacture in a modest way at Newark, Ohio, and had started to lose per annum more than a modest amount of money, I was told by Mr. Levis and Mr. Boeschenstein that Corning Glass Works had acquired the American rights to a German process for making fibrous glass. They wanted to undertake the fibrous glass development in this country, and the people from Corning would like to visit our operations, looking toward some sort of cooperation in the development of this new industry. At that time, Dr. Eugene Sullivan came to visit us at Newark, and I had the privilege of meeting him for the first time. As far as I can understand, I think Dr. Eugene Sullivan is the greatest living glass chemist. Dr. Sullivan, Dr. Hostetter, Dr. Littleton, Dr. Lillie and the late Dr. Taylor, of Corning, have contributed beyond measure to the development of fiber glass and to my training in glass technology.

We no more than started to make house insulation out of fiber glass than we found that the glasses of known composition were not sufficiently stable against humidity, or as we say in the glass industry, they did not have sufficient weatherability to be practical or usable for general insulation purposes.

At this time, Dr. Oscar Burch came forward with the composition which we manufactured for many years and called B glass (B for Burch) which was a calcium-sodium-borosilicate instead of a straight sodium-borosilicate or a soda-lime-silicate.

About 1934 we were actively and somewhat secretly exploring the possibilities of making textile fibers out of glass. I remember well, on a train one night, Mr. Jan S. Irvine saying to me, "Games, do you think we will ever make textiles out of glass?" My answer was, "Yes, but don't tell anybody because we will be rated

How well do you know your glass?

ILLUSTRATED IN THIS PICTURE IS A:

- ☐ 1. Modern flower bowl
- ☐ 2. 17th century prunted roemer
- ☐ 3. English royal goblet
- ☐ 4. 16th century Danish tea-glass

If you checked No. 2, you're right! This ornate wine glass, or roemer — with a hollow, prunted stem — bears an enameled scene of Mercury's rescue of the infant Bacchus. This type of prunted roemer was especially popular among Dutch glassmakers around 1690. Some 200 years later Wyandotte began supplying Soda Ash to the glass industry. Today, as in the past, Wyandotte is a working partner supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

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Founded by a Glassmaker to Serve the Glass Industry

as first-class damn fools."

In the development of textiles we had to get glass which had much more water stability than any glass we had evaluated and which could be pulled into fibers. At this point we employed as a consultant, Dr. W. J. McCaughey, of the Department of Optical Mineralogy, Ohio State University. Dr. McCaughey and one of his students, Dr. R. A. Schoenlaub, developed the alkali-free glass, which came to be known as E glass. This glass has been the basis and still is the basis of our textile business.

In the late thirties Mr. Paul Zimmerman came into our picture. Mr. Zimmerman's inventiveness and long experience in the manufacture of glass stimulated and brought forth many important developments.

In order not to make this talk too long, I have tried to confine it to the high points of my training as a glass man. To avoid making it pages of listing of names, I have confined it to people who were older than I or about the same age. I have also been taught by many younger than I who have worked for me and with me, and the story of those young men and what they have contributed would be very interesting. I hope some time to have an opportunity to record their various accomplishments.

Henry Ford used to give interviews to the newspaper reporters on his birthday. One year, on his birthday, a reporter said to him, "Well, Mr. Ford, you would say then that you are a graduate of the school of experience and hard knocks." Mr. Ford quickly answered, "Oh, no; when you graduate from the school of experience and hard knocks you are too old to do anything. If you are going to accomplish anything during your lifetime, you must learn from others."

I feel as though I have merely been the channel through which all of this technology flowed, and when I think of my own contribution to the technology of glass, I recognize that I have made some additions, but, by and large, most of the technology that has gone into the development of Fiberglas has been gathered from many, many sources and many brilliant men.

Inventions and Inventors

(*Continued from page* 86)

melted by an individual cover which extends over the whole of its length but conducts none or no substantial part of the heating current, the material being melted flowing downwardly between adjacent covers.

The covers should be made of a highly refractory non-metallic material which is also highly heat conductible. For example, highly refractive oxides such as zirconium oxide may be used, or nitrides, life titanium nitride or zirconium nitride, or borides, such as titanium boride or zirconium boride.

By means of this technique in which the rods are screened from contact with the material being melted, the repeated formation and tearing off of layers of silicon carbide is avoided, and the premature destruction of the heating rods due to this cause is prevented. The working life of the heating rods is lengthened, enabling larger uniform blocks of melt, and blocks of greater length to

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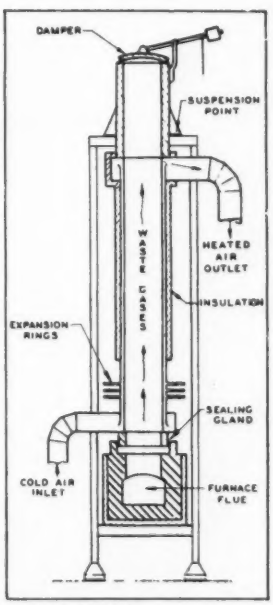

U.S. PAT. 2538446

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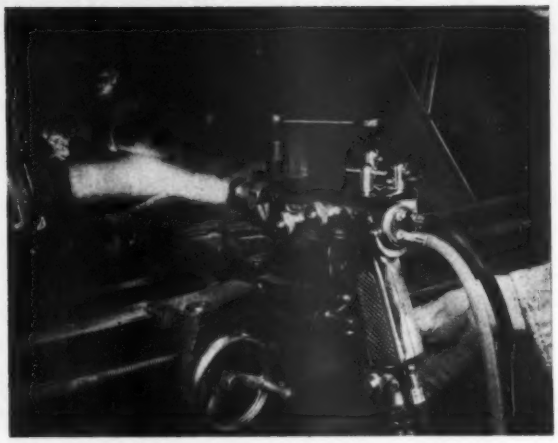
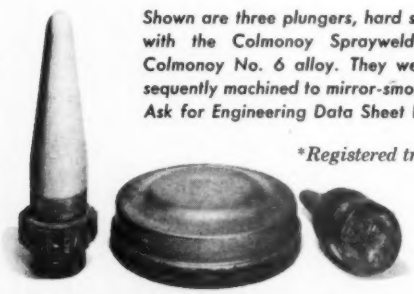


Plungers Last 15 Times Longer with Colmonoy Protection

Colmonoy Sprayweld hard surfacing has radically increased the life of glass plungers in glass container plants everywhere. Reports show at least 15 times (and up to 54 times) longer life can be expected from Colmonoy protected plungers.

As originators of the Sprayweld* Process (spraying and fusing hard-surfacing alloys), and with eight years of experience in the maintenance of glass plant machinery, only Colmonoy offers a dependable, complete line of alloys in forms for every application method. The Colmonoy Spraywelder (a powder metal spray gun) produces superior uniform overlays, uses compressed air to build dense porosity-free deposits. Colmonoy alloys, containing chromium borides, provide maximum wear life, improve finished ware by eliminating specks.

Let us tell you more about these money-saving alloys and methods. Write today.



Shown are three plungers, hard surfaced with the Colmonoy Spraywelder and Colmonoy No. 6 alloy. They were subsequently machined to mirror-smoothness. Ask for Engineering Data Sheet No. 34.

**Registered trademark*

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be produced, and also enabling a continuous melting process to be performed.

There were 9 claims and the following references cited in this patent.

United States Patents

677,070, Eddy, June 25, 1901; 683,107, Dumoulin, Sept. 24, 1901; and 750,753, Contardo, Jan. 26, 1904.

Glass Compositions

Infrared transmitting fluoride glass. Patent No. 2,819,977. Filed July 1, 1955. Issued January 14, 1958. No sheets of drawings; none reproduced. Assigned to Kodak Company by (Eastman K.) Paul F. De Paolis.

It is the object of the present invention to provide a glass which has all of the optical properties of fluoride glasses such as extremely high V value representing low dispersion and which in addition has an exceptionally long partial dispersion for blue light. The dispersion index:

$$V = \frac{N_D - 1}{N_F - N_C}$$

The following table shows two examples of glass batches made according to the preferred embodiment of the present invention:

	Example 1		Example 2	
	Weight Percent	*Mol. Percent*	*Weight Percent*	*Mol. Percent*
MgF_2	9.0	11.9	9.5	12.0
SrF_2	34.9	23.0	36.9	23.0
PbF_2	5.9	2.0	3.1	1.0
AlF_3	20.3	20.0	19.3	18.0
BeF_2	22.8	40.1	24.0	40.0
LaF_3	7.1	3.0	2.5	1.0
CaF_2	...	...	1.0	1.0
BaF_2	...	...	2.2	1.0
LiF	...	...	.3	1.0
NaF	...	...	.5	1.0
KF	...	...	.7	1.0
N_D	1.384		1.381	
V	95.5		99.6	

The VgF for example 1 is .526, which conforms by definition to:

$$VgF = \frac{N_g - N_F}{N_F - N_C}$$

A preferred embodiment of the invention is a glass resulting from fusion of a batch consisting essentially of approximately the following percentages by weight: magnesium fluoride, 9; aluminum fluoride, 20; berillium fluoride, 23; lanthanum fluoride, 7; lead fluoride, 6; and strontium fluoride, 35.

There were two claims and the following references cited in this patent.

United States Patents

2,466,509, Sun et al., Apr. 5, 1949 and 2,511,224, Sun et al., June 13, 1950.

CLASSIFIED ADVERTISEMENTS

WANTED: Glass technologist with raw materials analytical experience to be in charge of laboratory. Employment with domestic company for foreign assignment on temporary or permanent basis. Replies will be held in strict confidence. Arthur W. Schmid Company, Investment Building, Pittsburgh 22, Pa.

Sheet and Plate Glass

Film resistors. Patent No. 2,815,302. Filed March 12, 1954. Issued December 3, 1957. No sheets of drawings; none reproduced. Assigned to the Commonwealth Engineering Company by Bernard Ostrofsky and James W. Ballard.

This invention relates to the production of electrical resistance elements having a glass base.

Heretofore the chromium films deposited on glass bases did not exhibit extremely low values of temperature coefficient of resistance. Most chromium resistive films on borosilicate glasses while showing a high, controllable degree of ohmic resistance were so affected by temperature that the average temperature coefficient of resistance for a series was about 0.3 of 1 per cent /° C. over the temperature range of –55° C. to 105° C. and the specific values of given resistors was from about 0.1 to 0.4 per cent /° C.

It has been found that when chromium is deposited on a borosilicate glass such as Pyrex, the temperature coefficient of resistance, quite unexpectedly, may be materially improved by heating the resistor element at substantially red heat; most suitably this heating is effected in a reducing atmosphere. The heating not only improves the temperature coefficient but also is advantageous with respect to the adhesion of the chromium to the glass since the metal film is substantially burned into the glass in the process of invention.

This combination of factors is particularly important with respect to the production of resistors having values in the megohm range.

Such resistors are produced by initially forming a complete film of the metal on the glass and then cutting a spiral form in the metal to attain the high resistance element. With the structure of invention, the temperature coefficient is not affected by such cutting and the cutting itself is very cleanly and accurately achieved due to the intimate relation between the glass and the burned-in chromium film.

The borosilicate glasses, because of their thermal endurance and their low temperature coefficient of expansion (as low as 3.0×10^{-6}), are of particular utility in the practice of the invention, but other glasses and particularly glasses which are high in silica, may suitably be employed.

There were 10 claims and the following references cited in this patent.

United States Patents

1,739,256 Pender, Dec. 10, 1929; 1,964,322, Hyde, June 26, 1934; 1,991,774, Spencer, Feb. 19, 1935; 2,047,350, Alexander, July 14, 1936; 2,047,351, Alexander, July 14, 1936; 2,118,795, Littleton, May 24, 1938; 2,357,473, Jira, Sept. 5, 1944; 2,522,531, Mochel, Sept. 19, 1950; and 2,733,325, Cox, Jan. 31, 1956.

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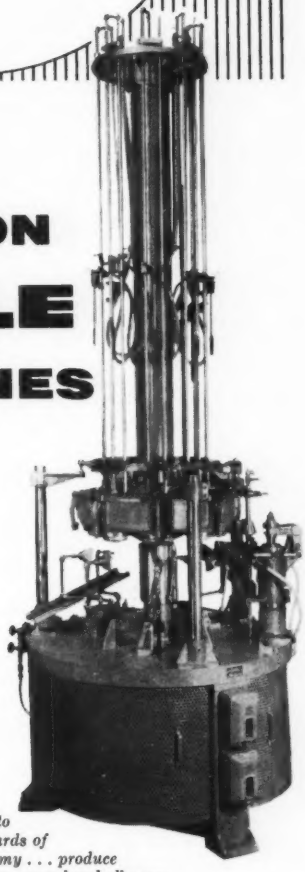

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